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THE IMPACT OF COMMUNITY MANAGED IRRIGATION ON HOUSEHOLD INCOME AND POVERTY REDUCTION
(THE CASE OF SEHARTI SAMRE WEREDA, TIGRAY, ETHIOPIA)

By

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As Thesis Research advisor, I hereby certify that I have read and evaluated this thesis Prepared, under my guidance, by **Sesen Hadush** entitled **The Impact of Community Managed Irrigation on Household Income and Poverty Reduction: The Case of Sehartisamre Wereda, Tigray, Ethiopia**. I recommend that it be submitted as fulfilling the Thesis requirement.

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DEDICATION

I dedicate this to my Mother W/RO KINDAHAFTI EYASU she brought me up with the heart of both a mother and father, who always instilling in the great value of education. No words could express my gratitude and love to you.

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my bona fide work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an advanced M.Sc. degree at the Mekelle University and deposited at the University Library to be made available to borrowers under rules of the Library.

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Acronyms

HH	House holds
IDD	Irrigation development department
IFAD	International Fund for Agricultural Development
MoWRD	Ministry of Water Resource Development
MoFED	Ministry of Finance and Economic Development
MoA	Ministry of Agriculture
MNRDEP	Ministry of Natural Resources Development and Environmental Protection
NGOs	Non-governmental organizations
OARD	Office Agriculture and Rural Development
PSM	Propensity score matching
PSNP	Productive safety net program
REST	Relief Society of Tigray
SAERT	Sustainable Agriculture and Environmental Rehabilitation in Tigray
SSWoARD	Seharti-SamreWoreda office Agriculture and Rural Development
SSWCUM	Seharti-SamreWoreda Co-operative Union Manager
SWCD	Soil and Water Conservation Department
TBoFED	Tigray Bureau of Finance and Economic Development
TBoARD	Tigray Bureau of Agriculture and Rural Development
TBoWRME	Tigray Bureau of Water Resource Mining and Energy
WAC	Woreda administration chairman
WOHFED	Woreda office head of finance and economic development
WUAs	Water users associations
ADCS	Adigrat diocese of catholic secretariat
AWDH	Andi-woyanedebrehaila
BoARD	Bureau of Agriculture And Rural Development
BWMERD	Bureau of Water, Mining And Energy Resources Development
BoPF	Bureau of Plan And Finance

BoFED	Bureau of Finance And Economic Development
Co-SAERT	Commission for sustainable agricultural and environmental rehabilitation in Tigray
CSA	Central statistics agency
DH	Department head
ATT	Average Effect of Treatment on The Treated
EEA/ EEPRI	Ethiopian economic association/ Ethiopian economic policy research institutions
EPRDF	Ethiopian people's revolutionary and democratic front
ESRDF	Ethiopian social rehabilitation and development fund
ETB	Ethiopian birr
FAO	Food and agricultural organization of the united nations
GOs	Governmental organizations
GDP	Gross domestic product
MDG	Millennium development goal
GNP	gross national product
WFP	world food program
DOARD	District office of agriculture and rural development
DOFED	District office of finance and economic development
CBN	cost of basic needs
PASDEP	A plan for acceleration and sustained development to end poverty
PRSP	poverty reduction strategy paper
SDPRP	sustainable development and poverty reduction program
MHA	Million hectare
M.A.S.L	METER above sea level

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ABSTRACT

Ethiopia is second populous county in Sub Saharan Africa with tremendous land and water resources. However, most of the areas used by settlement are extremely degraded, per capita land availability is dwindled and productivities of land and labor are reduced. Agricultural productivity is also very much affected due to variability of rainfall and drought. Agricultural production growth mainly comes through intensification and limited intensification. Since 1950s there are mixed experiences with promoting irrigation and other modern agricultural technologies in the effort of intensification. In the last decade, small-scale irrigation and rainwater harvesting are central to Ethiopia's new policy and strategy on agricultural and rural development.

This thesis explores the impact of irrigation income and poverty in northern Ethiopia. The overall working hypothesis of the thesis is that irrigation has an impact in improving household income and reduces the incidence, depth and severity of poverty in dry land areas of Ethiopia.
The analysis is based on primary household-level data collected from randomly selected households in two Tabia of SaharitiSamre in the 2011/12 agricultural year. To analyses the impact, descriptive statistics, poverty profile comparison, and econometrics matching method were used.

Research results indicate that households' access to irrigation has a significant impact on poverty reduction. Poverty among the user is less by 5% than poverty among the non-user. Irrigation has appositive influence agricultural development through increasing productivity, income of household and overall family employment.

CHAPTER ONE

INTRODUCTION

1.1.Poverty and Food Insecurity in Ethiopia

Ethiopia is a landlocked country situated in the horn of Africa and consists of nine independent regions and two city councils divided along ethnic lines. Occupying an area of 1.14 million square kilometers the country shares its international borders with five African countries: Eritrea in the North, Djibouti and Somalia in the East, Kenya in the South and Sudan in the west. Generally speaking Ethiopia has a hilly terrain, with mountainous plateaus and an undulating topography with maximum elevation of 4,600meters above sea level. The country is also split by the East African Rift Valley (running NE to SW) which has numerous of lakes.

The population, according to CSA, is estimated at 79.22 million (about 83.3 percent of the total live rural areas) and it is the second most populous country in sub-Saharan Africa. Almost one third of the population is less than 10 years of age and nearly half of the population (47.2%) is less than 15 years (CSA, 2007). The population distribution is related to factors such as altitude, climate and soil. Around 14% live above 2,400 meters (cool climatic zone), 75% between 1,500 and 2,400 meters (temperate zone). And 11% below 1,500 meters (hot climatic zone), despite this last category accounting for over 50% of the total land area (FRD, 2003). The overall average population density is around 65.8 people per square kilometer. However, large variations exist in Addis Ababa. Less than 10 people per square kilometer in the Ogden, Afar and the western lowlands near Sudan (ibid). As in many African countries, Ethiopia's population is growing at a rapid pace of 2.73% annually (CSA, 2007). If this trend continues Ethiopia population will continue to spiral, which may lead to increased problem of food insecurity and increased poverty.

Ethiopia has a number of factors including land that make it suitable for crop and livestock production. Nearly 73.6 million hectares of arable agricultural land exists within Ethiopia's total landmass of 1.1 million square kilometers, which are considered potentially suitable for agricultural production. Out of the total land suitable for agriculture, only 22 percent (less than 16.5 million hectares) of arable land are utilized for agricultural cultivation annually. Landholding in Ethiopia is characteristically small and fragmented with about 96 percent of the cultivated land area being landed by small holder farming and the remaining by commercial farming. The national average per capita of cultivated land holding is 1.02 ha per household.

Cultivable land area estimates vary between 30 to 70 Mha. Currently, high estimates show that only 15 Mha of land is under cultivation. For the existing cultivated area, our estimate is that only about 4 to 5 percent is irrigated, with existing equipped irrigation schemes covering about 640,000 hectares. This means that a significant portion of cultivated land in Ethiopia is currently not irrigated,(IWMI, 2010) so well-managed irrigation development is a key in helping Ethiopia to overcome major challenges including population pressure; soil and land degradation, high climate variability, and low agricultural productivity.

In addition, agricultural water development is crucial to improve smallholder livelihood and income in Ethiopia, since irrigation can help farmers increase their crop production, increase crop variety, and lengthen their agricultural seasons. Despite its enormous human and natural resource potential, the sad reality is that, Ethiopia is classified among the least developed countries in the world; and is often associated with recurrent drought, poverty and famine. According to 2007 World Human Development Report, the country has the lowest GNP per head in the world, Reports from the Ministry of Finance and Economic Cooperation of Ethiopia also attest to the seriousness and extent of poverty prevalence in the country.

Poverty is widespread in all parts of the country and 30.4% of the population lived below the national poverty line in 2010/11.The proportions of people who are experiencing poverty are highest in rural areas (30.4%), compared with the 25.7% in urban areas. The gap in poverty between rural and urban areas was narrowing until 2004/05, but it slightly widened after 2004/05(MOFED2010/11). The proportion of food poor people (food poverty head count index)

in the country is estimated to be 33.6% in 2010/11 while it stood at 34.7% in rural areas and 27.9% in urban areas. Agriculture is heavily reliant on rainfall and productivity and production are strongly influenced by climatic and hydrological variability that are reflected as dry spells, drought and floods. Droughts and floods are endemic, with significant events every 3 to 5 years, Awulachew et al (2005)

Ethiopian government gives emphases and design policies and strategies to improve the livelihood of the rural population through agricultural development. Currently, government provides special attention for agricultural sector by designing growth and transformation plan to fastest economic growth throughout the country, and to improves the living standard at household level and to set the country at middle level economic growth country's in the world in the next 15 to 20 years. This plan designed and starts to apply in the whole sectors throughout the country but particularly focused on the area that has been with high rainfall variability and high moisture deficit to tackle the problem of food insecurity that has persisted for decades. Then, one solution of poverty reduction strategy of the government is the use of supplementary irrigation from either traditional or modern water harvesting structures is considered the primary measure to be taken against the problem. In this direction government of Ethiopia is making serious efforts by allocating a fairly large amount of budget for the development of irrigation structures.

Irrigation development has been identified as an important tool to accelerate economic growth and rural development, and is considered a cornerstone to food security and poverty reduction in Ethiopia. Irrigation generates an average income of approximately US$323/hectare (ha) under smallholder-managed irrigation systems compared to an average income of US$147/ha for rain fed systems (Hagos*et al*., 2009). Irrigation contributed approximately 5.7 and 2.5% to agricultural Gross Domestic Product (GDP) and the overall GDP, respectively, during the 2005/2006 cropping season. By the year 2009/2010, the contribution of irrigation to agricultural GDP and overall GDP is estimated to be approximately 9 and 3.7%, respectively (Hagos*et al*., 2009).Irrigation development is good for country like Ethiopia for three reasons. First it supports the realization of food self-sufficiency and food security. Secondly, it improves the living quality

and standard of the people through the provision of sustainable agriculture and thirdly, it enhances the contribution of irrigation in attaining development priorities, programs and objectives (Taffa, undated).

Based on the above mentioned of irrigation benefits, the study were carried out in Andi-woyaneDebrehaila and Addis-AlemTabias (kebelle's) at Seharti-SamreWoreda. These two Tabias have benefited from irrigation due to this tabia have good access of water from Haiba micro damand other water resource options. Thus, this study is intended mainly to identify the impact of the poverty of irrigation on the house holds income and poverty reduction, To this end, this particular study aims at investigating whether the access to community managed irrigation has positive impact on rural household-income and improves the living standards of households, so this indicates that a household has been above poverty line**.**

1.2. Statement of the Problem

Major constraints to agricultural growth of Ethiopia are population pressure coupled with the dominance of the use of traditional agricultural production technology, including traditional farm tools and farming practices, low application of modern inputs like improved seeds and fertilizers, and poor animal breeds. The country's capacity to support agriculture production through development of irrigation has been weak (Mengistu, 2000: Destabeyere, 2004). For a country facing recurrent drought, with severe consequences for development, the need for irrigated agriculture cannot be over-looked. Ethiopia cannot hope to meet its large food deficit through rain-fed agriculture alone. Even under favorable weather conditions with very low annual growth in only rain-fed agricultural production, the country could still face millions of tons of cereal deficit for decades to come. The economic impact of irrigation and the contribution of irrigation to food security and as an engine of development are new themes in research programs. They have not been systematically addressed in the past. Most research has sought to find ways to improve irrigation performances in the operational sense. But currently, as the issues of food security and poverty reduction are becoming the global agenda, it started giving emphasis on the importance of increasing yields and income from irrigated agriculture to meet food needs and to reduce poverty. The rationale behind this is that with the

availability and proper utilization of irrigation in an area, crops can be grown more than once in a year through supplementary irrigation. By the year 2009/2010, the contribution of irrigation to agricultural GDP and overall GDP is estimated to be approximately 9 and 3.7%, respectively (FitsumHagos, GodswillMakombe, Regassa E. Namara and SeleshiBekeleAwulachew, 2009) Cropping intensity may be higher than the rain-fed agriculture (Merrey, 1997).

Moreover, irrigation is believed to increase the productivity of other critical inputs like improved seeds, chemical fertilizers, land and labor. To get out of the recurrent food insecurity and poverty prevailing in Ethiopia, different means, tools and strategies have been suggested by different individual and groups. Among which irrigation development and wise utilization of surface and ground water are the ones. The small-scale irrigation development will be beneficial for the country for three reasons. First, it supports the realization of food self-sufficiency and food security. Secondly, it improves the living quality and standard of the people through the provision of sustainable agriculture.

Thirdly, it enhances the contribution of irrigation in attaining development priorities and poverty alleviation. Using of irrigation allow to grow varieties of crops in sequence on the same field with in a year. The succeeding crop is planted only after the preceding crop has been harvested. Thus, irrigation increases volume of output obtained from a given field in a year. Moreover, in moisture deficit areas, the use of supplementary irrigation will make the nutrients in the soil available to the crops to grow to their full maturity. In doing so, it contributes to the increase in productivity of a given farmland. That means, the use of irrigation is one of the spectrums of technologies available to increase agricultural production. And one can also sense that there is an observable income gap between users and non-users of irrigation. The improvement in agricultural production determines the rate of economic development of the nation. Agricultural productivity and production can be increased either by increasing necessary inputs or by introducing modern agricultural technologies. Given agricultural technologies and input levels, agricultural productivity and production can be increased through improvement in efficiency of production. Moreover, in the area, significant attempt has not been made to study and analyze the impact of irrigation on different economic, social and cultural life of rural farmers. Therefore, this study is initiated to analyze the impact of

irrigation on production and income of rural households. It also, assesses issues with respect to community managed irrigation systems that need government attention and interventions.

1.3. Objectives of the Study

The overall objective of this study is to examine the impact of irrigation on the household income and poverty reduction. To meet this overall objective, the research has the following specific objectives:

1. To compare the levels of income of irrigation user and non-user households.

2. To assess the contribution and impact of irrigation in poverty alleviation.

Beside the main objective the study examines the constraint and opportunities of the irrigation users in the study area.

1.4. Significance of the Study

The attainment of the objectives mentioned above is important tool for agricultural development of the country. This is because determining the contribution of irrigation to household income improvement as well as determining the standard of living of the rural household and food security program achievements. Ensuring adequate and reliable supply of water increases yields of crops. Along with higher yields irrigation increases incomes and reduces hunger and poverty. Where there is irrigation widely available under nourishment and poverty are less prevalent. Even landless Laborers and small holder farmers who lack the resource to employ irrigation themselves often benefit through higher wages, lower food prices and a more varied diet (FAO, 2003). To this end, identifying, analyzing and understanding the impact of small scale irrigation on household income and poverty reduction.

1.5. Scope and limitations of the Study

The study covered two districts of south-east zone, Tigray region. It analyzed the impact of irrigation on household income and poverty reduction. The study was limited to only two districts due to limited resources and time. The research was undertaken in the two districts assumed to have similar ecology, economic, social and demographic characteristics as compared to the area and variations that exist within the region. In this study, household level production data of only one-year period (2011/2012) was used. The sample size is also restricted to one hundred thirteen farmers. In the course of survey work, it was found that farmers are very reluctant to frankly respond to some of the questions, particularly to questions of resource holdings such as number of livestock owned, land size, yield and household incomes. Also as farmers do not keep records and due to memory lapse, some of the questions lack exact answers and the respondents attempted by giving ranges or estimates.

1.6. Organization of the Thesis

The thesis has five chapters. The first chapter is concerned with the introductory part, which comprises the background, statement of the problem, objectives of the study, significance of the study, and scope and limitation of the study. The second chapter deals with the review of literature. The third chapter focuses on the description of the study area and methodology of the study is covered in the chapter. The chapter briefly discusses procedures followed in data collection, estimation procedures, model used and hypothesis settings. Results and discussions are given in chapter four. The last part of the thesis is the summary and conclusion.

CHAPTER TWO

LITERATURE REVIEW

2.1. Concept of irrigation

Water is the greatest source of humanity. It not only helps in survival but also helps to have comfortable life. Besides various other uses of water, the largest use of water in the world is for irrigating land. Irrigation in fact is nothing but is a continuous and reliable water supply to different crops in accordance with their water requirement. The basic problem of water distribution in the world is the temporal and spatial differences that exist in the supply and demand of water. A crop requires certain amount of water at certain fixed intervals throughout its period of growth. Irrigation is required at dry and last rainy period's .Because at dry period irrigation give important role in order to produce food crops and cash crops, also at last rainy period as Ethiopian situation especially country that rainy season as observed rainfall starts late and ends early, so in order to supplement the crop irrigation provides a greatest role in order to produce more yield.

In tropical countries like Ethiopia, the first two of three essential requirements of plant growth, that is, moisture needs to be supplemented frequently by artificial application of water. Thus, irrigation is supplementary to rainfall when it is either deficient or comes irregularly or at unreasonable times. Irrigated agriculture is one of the critical components of world food production, which has contributed significantly to maintaining world food security and to the reduction of rural poverty. About 17 percent of global agricultural land is irrigated and contributes about 40 percent of the global production of cereal crops (WCD 2000).

Community managed Small-scale irrigation can be defined as irrigation, usually on small plots, in which small farmers have the controlling influence, using a level of technology which they can operate and maintain effectively. Community managed small scale irrigation is, therefore, farmer-managed: farmers must be involved in the design process and, in particular, with decisions about boundaries, the layout of the canals, and the position of outlets and bridges.

Although some small-scale irrigation systems serve an individual farm household, most serve a group of farmers.

2.2. Socioeconomic Impacts of Irrigation

In addition to increasing crop production and farm and family incomes, improved irrigation access significantly contributes to rural poverty reduction through improved employment and livelihood within a region (Chambers 1988; Barker et al., 2000). Indirect benefits, such as more stable rural employment as well as higher rural wage rates, help landless farm laborers obtain a significant share of the improved agricultural production. In addition to yield improvement and intensive production practices, better irrigation infrastructure and reliable water supply also enhance use of other inputs like fertilizers and HYV. This intensification of agricultural practices generates additional employment opportunities in the rural sector. The irrigation induced benefits are not limited to farming households but also affect broader sectors of the economy by providing increase opportunities to growing rural service sectors and other off-farm employment activities (Mello1966). Examples of such opportunities are additional employment creation for landless laborer in agro-industries, rural marketing and other off-farm activities like house construction and basic infrastructural building. In turn, this feedback process increases the demand for employment many fold and generates additional wealth creation and/or capital accumulation in the rural sector All of these benefit processes create transformation within rural and urban sectors, and the feedback mechanism in an economy has significant importance in designing location-specific poverty reduction strategies. The total beneficial impacts of irrigation development, both direct and indirect, can be summarized under the following categories:

1. Increased crop production (yield improvement) and increased farm income.

2. Increased cropping intensity and crop diversification opportunities and the feasibility of year-round crop production activities.

3. Increased farm employment—more employment opportunities for farming families as well as for hired laborers in the locality.

4. Increased farm consumption and increased permanent wealth (permanent asset accumulation due to irrigation). This has significant implications for reducing intrinsic food insecurity in a region.
5. Reduced food (crop) prices allowing access to food for all, which is more beneficial to landless and subsistence families and provides better nutrition intake. This is also equally beneficial to urban poor and city dwellers, since they spend more than 50 percent of their daily income on food items.

6. Reduced friction in the rural economy and reduced transaction costs including reduced farm marketing costs due to increased access to farm link roads and to other improved farm and non-farm related services in the region.

7. Increased farm income (for farmers) and increased farm and off-farm employment opportunities for rural landless laborers result in better school attendance of children of farm laborers and improved social capital in society. This is due to the income effects of irrigation, since education is still a luxury compared to other basic needs: foods, clothes, health, etc.

Improved rural infrastructure always coincides with irrigation facilities. This greatly reduces transaction costs and rural marketing costs and other frictions associated with the farming sector. The benefits generated by these activities are also called indirect benefits of irrigation investments. These indirect irrigation benefits, usually intangible, are not fully captured by farming communities alone; rather, they are shared by larger sections of society. For example, lower food grain prices benefit poor urban and rural landless communities more by enabling them to purchase required food items at affordable prices. Keeping food prices at relatively low levels also greatly assists the industrial sector to avoid the pressure of increasing the real wage rate. In this process, improved agriculture indirectly subsidizes the industrial sector of the economy as well.

2.3. Estimation of poverty line

The poverty indices comparison between irrigation users and non-irrigation users has been performed using two poverty lines. These are the extreme poverty line (basic consumption requirement poverty line) and moderate poverty lines. Extreme poverty line was estimated based on the cost of fulfilling the minimum calorie intake for a healthy life being 2,200 calories, while the moderate poverty line was derived based on a food poverty line of 2,750 calories (which is 125% of the 2,200 calories level); which is commonly used for welfare monitoring by the Ethiopian Central Statistics Agency.

2.4. Overview of Ethiopia's Agricultural Development Policy/Strategy

During the last 17 years the government formulated and implemented a range of economic and sartorial policies and strategies to re-energize the agriculture sector and accelerate economic development of the country. This has occurred in the form of an agricultural –centered development strategy known as the Agriculture Development Led Industrialization (ADLI). The strategy (ADLI) revolves around making the small agricultural farmers the engine of growth. It is argued that what the average farmer needs to kick start the growth process is access to a combined provision of land, labor, water and capital (MO FED, 2000). The government also sees ADLI as a strategy that will ensure the equitable sharing of growth benefits. Its essence is that agricultural growth is taken as the driving force for ensuring household and national food security and as engine for industrialization through its effects on demand for industrial goods, supply of raw materials and exports.

Under ADLI emphasis is given to the transformation of the smallholder farmer from subsistence to a more business and market-oriented agriculture producers. This has occurred through agricultural extension which promotes the adoption of improved technological inputs and practices, expansion of small and large scale irrigation schemes, and expansion of credit schemes. Furthermore, the adoption of a development path compatible with different agro-ecological zones and area based specialization as well as supporting diversification of agricultural communities has been a strong feature. Furthermore, integrating farmers with markets and expanding access to primary education, primary health care, rural water supply and

rural roads are some of the ADLI activities aimed to bring a positive change for Ethiopia's small farmers and reduce their vulnerability to external shocks. The main criticism of ADLI is that the strategy is biased against the development of the industrial and other non-agricultural sectors. These sectors are also deemed as vital to providing livelihood strategy options for those leaving the land. They argued that, without strong linkage between agriculture and the non-agricultural sectors and equal policy support for the latter, sustainable development will not be realized in long run. In line with ADLI's objectives a number of development programs have been put in place in past years, among these is Sustainable Development and Poverty Reduction Program me, formulated in 2006, and implemented from 2001/02 to 2005/06. Its successor, the Plan for Accelerated and Sustained Development to End Poverty (PASDEP), runs from 2006/07 to 2010/11. In both programmers agricultural development was adopted as a central and strategic direction for poverty eradication in Ethiopia. The program calls for the rapid growth of agriculture in particular that of the small holder farming with the goal of extricating the economy from dependence on food aid and the generation of rural employment opportunities and income.
PASDEP also provides a framework for the five-year national and sect oral development programs which includes the agricultural sector strategies for the years 2006 – 2010. Under this plan greater emphasis is given for the expansion of medium and large irrigation schemes, commercialization of agriculture, diversification of production and exports, and private sector investment in order to move farmers beyond subsistence farming to small-scale market-oriented agriculture (Hail, 2008)

2.5. Brief history of irrigation development in Ethiopia

Irrigation is practiced in Ethiopia since ancient times producing subsistence food crops. However, modern irrigation systems were started in the 1960s with the objective of producing industrial crops in Awash Valley. Private concessionaires who operated farms for growing commercial crops such as cotton, sugarcane and horticultural crops started the first formal irrigation schemes in the late 1950s in the upper and lower Awash Valley. In the 1960s, irrigated agriculture was expanded in all parts of the Awash Valley and in the Lower Rift Valley. The Awash Valley saw the biggest expansion in view of the water regulation afforded by the construction of the Koka dam and reservoir that regulated flows with benefits of flood control,

hydropower and assured irrigation water supply. The potential of irrigation water in Ethiopia is quite high and its drainage pattern is of great importance to its neighboring countries. From the total run off 110 billion m^3 about 90% flows down to neighbors through eleven major rivers. Traditional irrigation is very old in Ethiopia. These traditional small scale irrigation schemes are in general simple river diversions which are subject to frequent damage by flood. From the total potential area, the area irrigated is low and the reasons on the past regime is due to lack of fund, data on different factors of natural resources, infrastructure, skill, research and suitable policy and hydro-politics of the region. For much of the lifetime of the Derg, very little attention was paid to small-scale and traditional irrigation schemes constructed and managed by peasant farmers. With the nationalization of industrial and agricultural enterprises, the government's emphasis was to promote high technology water development schemes managed by state controlled agro-industrial and agricultural enterprises. It was only in the second half of the 1980s, as a result of devastating famine of 1984/85 that the Derg began to show interest in small-scale water management schemes. The establishment of the Irrigation Development Department (IDD) within MoA at the end of 1984, a body entrusted with the development of small-scale irrigation projects for the benefit of peasant farmers, signaled a new approach to water development by the military government. However, progress was slow. From the mid- 1980s to 1991, IDD was able to construct some 35 small schemes, of which nearly one-third was formerly traditional schemes used by peasants (MoA, 1993; Desalegn, 1999).

Community managed Small-scale irrigation development was carried out by the surface water division of the Soil and Water Conservation Department (SWCD) of the Ministry of Agriculture (MoA). In 1984, the division was separated from SWCD and upgraded to IDD. In 1987, the activities of MoA were being decentralized to zonal offices, and IDD staffs were being transferred to strengthen the capacity of the zones. However, in 1992, a new Ministry of Natural Resources Development and Environmental Protection (MNRDEP) was established, with the responsibility for soil and water conservation, rural water supply and sanitation. Although the Ministry retained responsibility for providing agricultural support services, the IDD was dissolved and its responsibilities were transferred to regional Natural Resources Bureau. In August 1995, MNRDEP was dissolved and its responsibilities were shared between MoA and the

Ministry of Water Resources (MoWR). Under the new arrangements, responsibility for irrigation development was given to the Bureau of Water, Minerals, and Energy Resources Development (BWMERD) while MoWR has an overall policy, planning and regulatory role in respect to water resource development (JICA, and OIDA, 2001).

2.6. Ethiopian water potential for Irrigation Development

Ethiopia has an estimated 2.6 billion meter cube of usable ground water potential. Estimates showed that there is sufficient water in the country to develop about 3.73 million hectares of which only about 190,000 ha (4.3% of the potential) is actually irrigated land under full irrigation in Ethiopia (MoWRD, 2006). However, irrigated agriculture has realized only 4.3% of its estimated potential and in terms of output it accounts for approximately 3% of the total food crop production (MoFED, 2007).

There is little information on the extent to which the so far developed irrigation schemes have been effective in meeting their stated objectives by improving their household's income attaining food self-sufficiency and eradicating poverty (Abonesh et al., 2006). Therefore, currently, the government is giving more emphasis to the sub-sector by way of enhancing the food security situation in the country. Efforts are being made to involve farmers progressively in various aspects of management of small-scale irrigation systems, starting from planning, implementation and management aspects, particularly, in water distribution and operation and maintenance to improve the performance of irrigated agriculture.

Ethiopia cannot meet its large food deficits through rain-fed agricultural production alone. Cognizant to this fact, the government has taken initiatives towards developing irrigation schemes of various scales. This will continue and be further strengthened during the coming years. Now on the EPRDF regime starts to focus expansion of irrigated land and uses the potential of irrigation water sources. Therefore, careful planning and management of this precious resource is inevitable for the overall development of Ethiopia economy.

In Ethiopia, irrigation schemes are classified into small, medium and large scale. Small-scale schemes are those covering an irrigated area of less than 200 hectares and growing primarily subsistence crops, Yosuf K (2004),

2.7. The need for community managed small-scale irrigation in Ethiopia

In Ethiopia, irrigation has a long tradition (Kloos, 1990). One of the main targets of irrigation systems is to fortunate agricultural production in qualitative as well as in quantitative meaning (Mengistu, 2003). Harvests shall be enlarged so that people either produce enough food for the non-harvest time or to sell their overproduction and earn some money to buy food. Another opportunity to produce more food crops is irrigated gardening, an activity mainly done by women. In Ethiopia, there has been a revival of irrigation during the last decades in order to enhance rural development and food security (FAO/WFP, 2006). Given that 85 percent of the people are employed in agriculture (Mengistu, 2003), developing this sector could help to reduce poverty and enhance food security of the majority of the Ethiopian people. The absence of off-farm income in rural areas has also contributed to the high population pressure on arable land, which leads to fast deterioration of natural resources. This situation will remain a challenge until a high rate of agricultural transformation coupled with maximum and sustainable agricultural productivity (per unit area of land-intensification) takes off from the present crisis. Realizing the present socio-economic situations, it is evident that Ethiopia cannot meet its food security and food self-sufficiency objectives using the prevailing land and water use systems (McCornick et al, 2003). Then, this increased problem of food insecurity and increased poverty if sustainable solutions are not found in the future.

2.8. Characteristics and Functioning of irrigation schemes

Before us discussing the survey results with respect to irrigation, it is essential to describe what does community managed irrigation means in the context of this particular study. Community managed irrigation system is an irrigation scheme in which the user community performs all or part of the activities of irrigation management. The physical activities such as operation and maintenance of the existing schemes, development of new schemes, organization and formulation of by-laws for Water Users Associations (WUAs), ensuring equitable water

distribution and mobilization of community lab our and financial contributions for the sustenance of the schemes are performed by the community. Moreover, the community delegates representatives (irrigation committee) to deal with the government on issues of irrigation development and managements. These are some of the major roles of the community in community managed irrigation system.

2.9. Irrigation and Implications for Poverty Alleviation

The first direct impact is on output levels. Irrigation boosts total farm output and hence, with unchanged prices, raises farm incomes. Increased output levels may arise for any of at least three reasons. Firstly irrigation improves yields through reduced crop loss due to erratic, unreliable or insufficient rainwater supply. Secondly, irrigation allows for the possibility of multiple-cropping, and so an increase in annual output. Thirdly, irrigation allows a greater area of land to be used for crops in areas where rain fed production is impossible or marginal. Hence irrigation is likely to boost output and income levels. Labor income is a growing part of poor's income, and laborers are growing share of the poor. Finally, output may be increased because irrigation enables the use of complimentary inputs, such as high yielding varieties (Michael Lipton, 2003)

Declining real world market food prices is one of the main factors for the reduced rate of expansion of irrigated areas during the late 1980s and the 1990s, unlike in earlier decades. Declining food prices have also created less incentive for national governments and international development agencies to provide additional funding to the irrigation sector. The real world price of rice dropped from US$ 1,050/mt in 1974/75 to US$ 200/mt in 1998 (at 1995 US$ value); in other words, thereal price of rice has dropped more than 75 percent during the last 25 years. Similarly, the real price of wheat in the world market has declined from US$ 500/mt in 1975 to US $ 175/mt in 1996, more than a 65 percent decline in real terms over the last 20 years. The level of decrease in world food prices is, in fact, the result of the higher rate of expansion of world food supply compared to the rate of increase of food demand caused by population growth. During the period from 1960 to 1990, global cereal production has expanded by more than 100 percent, whereas global population expansion is around 70 percent (FAO STAT 1998).

Timely access to irrigation infrastructures in the past was one of the main reasons for the level of increase in food production worldwide, along with other contributory factors like timely availability of HYV, fertilizers and other technologies. The reduced price of food grains in world markets is one of the reasons for the recent reductionof rate of returns from irrigation projects, limiting the incentives provided by governments, development agencies and private sector investment to the irrigation sector. Kikuchi et al. (2001) have estimated that the benefit-cost ratio of irrigation construction investment in Sri Lanka as a whole had picked up more than 3.5 points in the mid-1970s and then sharply declined to a level of 1.5 in the mid-1990s.

The slack crop prices in Sri Lanka, and in the world market, was one of the major factors for such a declining benefit cost ratio and declining additional investment in the irrigation sector in the recent past. This is equally applicable to several other countries in the region. The benefit-cost ratio of an irrigation project is in fact a very important criterion for the justification of new investment in the sector, which is very sensitive to fluctuation in output prices. Declining real world market food prices also have large implications for the level of cost recovery and service charge set in a system. Issues like who should pay what for improved irrigation access in a region are important. Due to the inelastic nature of demand for food, farmers are not the only beneficiaries of increased food production in the face of declining food commodity prices. Rather, a larger section of society benefits from improved irrigation and expanded crop production. Direct benefits of irrigation accrued at farm level, such as increased crop yield and farm income, are often only a small fraction of the total benefits to society. An irrigation impact study in Alberta and Saskatchewan, Canada, reported that only 15 to 20 percent of the total benefits of irrigation development go to the farming sector in terms of increased agricultural production, with the remaining incremental benefits of irrigation projects realized by wider sections of the society (Hill and Tollefson 1996). The widespread secondary benefits of irrigation include rural employment and economic activities induced in the region. Their importance, compared to direct benefits, has been increased in the face of declining real world market food grain prices. This has large policy implications on cost recovery policy and the level of service fee set in an irrigation system and in the efficient sharing of irrigation service costs across different sectors of society.

2.10. Irrigation Development inTigrayRegionalState

Tigray region is situated in the northern tip of Ethiopia.The topography of the region is predominantly mountainous and the elevation ranges from 500 meters above sea level in the eastern part of the region (Erob) to 3900 meters in the southern zone near Kisad Kudos' (Tassew, 2000). The climate includes all the three categories: kolla (lowlands), weynadega (midlands) and Dega (highlands). The average minimum temperature is 5^{o}C and the maximum 40^{o}C. The region is one of the most drought prone and food insecure regions of Ethiopia. The state of Tigray has an estimated area of 56,000 km^2. Tigray total projected population size has estimated about 4,682,312 of which 3,304,885 or 79.2 percent of the population are estimated to be rural inhabitants, while 973,356 or 20.8 percent are urban. (BoPF, 2010). The average land holding is about one hectare. This varies from 0.5 hectare to 0.9 hectare in the densely populated highlands and nearly 1 hectare in the lowlands (ASS, 2008). Majority of the population in the region employedin agriculture this sector. Agriculture is dependent on unreliable rainfall. For many years rainfall has been very low and erratic. As a result, repeated crop failure and scarcity of food have forced inhabitants to depend on famine relief in the form of food for work.

There are 103 irrigation schemes developed in Tigray regional state. A total of 4,932.8 hectares of irrigated area of which, 3,956.80 hectares are from small-scale, and 976 hectares from medium scale, with 22,632 beneficiaries reported. The organizations involved in irrigation development in Tigray region include: Sustainable Agriculture and Environmental Rehabilitation in Tigray (SAERT), Bureau of Water Resources Development and Bureau of Agriculture and Rural Development. The NGOs and donors involved in the development of irrigation schemes in the region are many; some of the major ones are Ethiopian Social Rehabilitation and Development Fund (ESRDF), Relief Society of Tigray (REST), World Vision, Raya Valley, Ethiopian Orthodox Church, ADCS (Adigrat Diocese of Catholic Secretariat) and IFAD (International Fund for Agricultural Development).(Seleshi et al.,2007).

The climate of Tigray is mainly semi-arid and for most of the region the major rainy season (locally called *kiremti*) lasts for 3 to 4 months, between June and mid-September. The mean annual rainfall ranges from 980 mm on the central plateaux to 450 mm on the north-eastern escarpments of the region. The annual rainfall shows a high degree of variation with a coefficient of variation ranging from 20% in western to 49% in eastern parts of Tigray. Temperature ranges depend on altitude and vary from temperate type in the higher areas to tropical in the lower areas. The average temperature in the region varies from 16^{o}C in the south west to 25°C in the extreme eastern areas. The economy of Tigray is dominated by peasant agriculture involving traditional methods of crop production and livestock rearing. Agriculture accounts for 50.8% of the regional Gross Domestic Product. However, the annual growth rate of production is 1.2%, which is below the national average, while population is growing at 2.5% per annum. (BoPF, 2010)

The water resource of Tigray is not well studied. Available studies indicate that only about five perennial streams have flow rates of more than 10litres/second. The loss of water through the three major drainage systems of the region during the annual rainy season is immense. In total through the Tekeze, Mereb and Dennakil basins 9 billion cubic meters of water goes from Tigray to neighboring countries every year; this is almost equivalent to the 9.21 billion cubic meters of the total estimated rainfall in the region. If 50% of the 9 billion cubic meters of runoff was used, 500 thousand hectares (ha) of land, which could feed three-times the present population of Tigray, could be irrigated(TH,2010)

2.11. Empirical studies on irrigation

The study carried by Shumba and maposa (1996) revealed that, income generations and food security are major reasons for joining the scheme. Employment creation was considered as a secondary objective. Plot holders meet their objectives by growing crops in the summer and vegetable in the winter. Notwithstanding the constraints, like unreliable water supply, limited cash for input purchase, poor roads and limited market outlets, the plot holders' objectives have been met to some extent. They reported having achieved improved food security, high incomes and increased employment opportunities in comparison to "without irrigation" situation. The study also revealed that there was complementarily among the objectives of food security, income generation and employment creation

2.12. Socio-economic role of irrigation schemes in the study area

The objective of irrigation projects is to increase agricultural production means it results increase households income and consequently to improve the economic and social well-being of the rural population on the study area. However, changing land use patterns may have other impacts on social and economic structure of the project area. Small plots, communal land use rights, and conflicting traditional and legal land rights all create difficulties when land is converted to irrigate agriculture. These problems are faced on the study area on the first phase of construction of dam before 14 years ago, but this problem is solved now a day by fair redistribution of land on that period. Now after that there is no problem of land ownership right questions.

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA

3.1. Socio-economic profile of Tigray Regional State

Physical Characteristics:-Tigray Regional State is found in the northern part of Ethiopia, It extends between 12^0 15'N and 14^0 57'N latitude and 36^0 27' E and 39^0 59'E longitude (TBoFED, 2010). It has an area of 56,000Km^2 and accounting for 5 percent of the country's land area. This forms a total of two borderlines and physical contacts with other regional states such as with Amhara Region in the South and West & Afar Region in the East and also shares with international borderlines.

Population:- According to the 2010 report of Bureau of Finance and economic Development projection of Population size(department of Plan and economic Development) Census result, the population of the region is projected (population growth rate of 2.5 percent per annum) to be 4,682,312 million in the year 2010. The share of rural and urban population is 3,708,956 and 973,356 respectively. The average household size was estimated at persons are (3.4 and 4.6 Persons per household for urban and rural areas respectively). Regional average household size was estimated at persons are 4.4 person per household. (TBoFED, 2010).The crude population density of the region was 86 persons/ per km^2.The regional 80.47% of the rural population has living on farming activities.

Agriculture development in the region still at the subsistence level and it is the mainstay of the economy the country and the region. It is the means of livelihood for almost all of the rural population, and contributes to 50.8% of Regional Gross Domestic Product (GDP),industry 18.4% and services also contributes 30.8%. Moreover, agriculture is the main source of domestic food production and major supplier of raw materials to domestic manufacturing industries and source of foreign exchange earnings (TBoARD, 2010).The livestock population of the region is estimated at, According to Bureau of Agriculture and Rural Development record in 2010 report, these are 3,242,931cattle, 1,149,717 sheep, 2,621,227 goats,456,093 donkeys, - horse, 4,920

mules,32,288 camel,4,266,077 poultry and 195,662 bee hives are found throughout the region. (TBoARD,2010). Land size in the highlands is increasingly diminishing due to high population pressure. According to land utilization survey conducted in the year 2010, Tigray region has around 891,187 peasant landholders and the average land holding is about one hectare. This varies from 0.5 hectare to 0.9 hectare in the densely populated highlands and nearly 1 hectare in the lowlands (ASS, 2008).The Regional average land holding per household was 1 hectare. This is slightly greater than the national average.

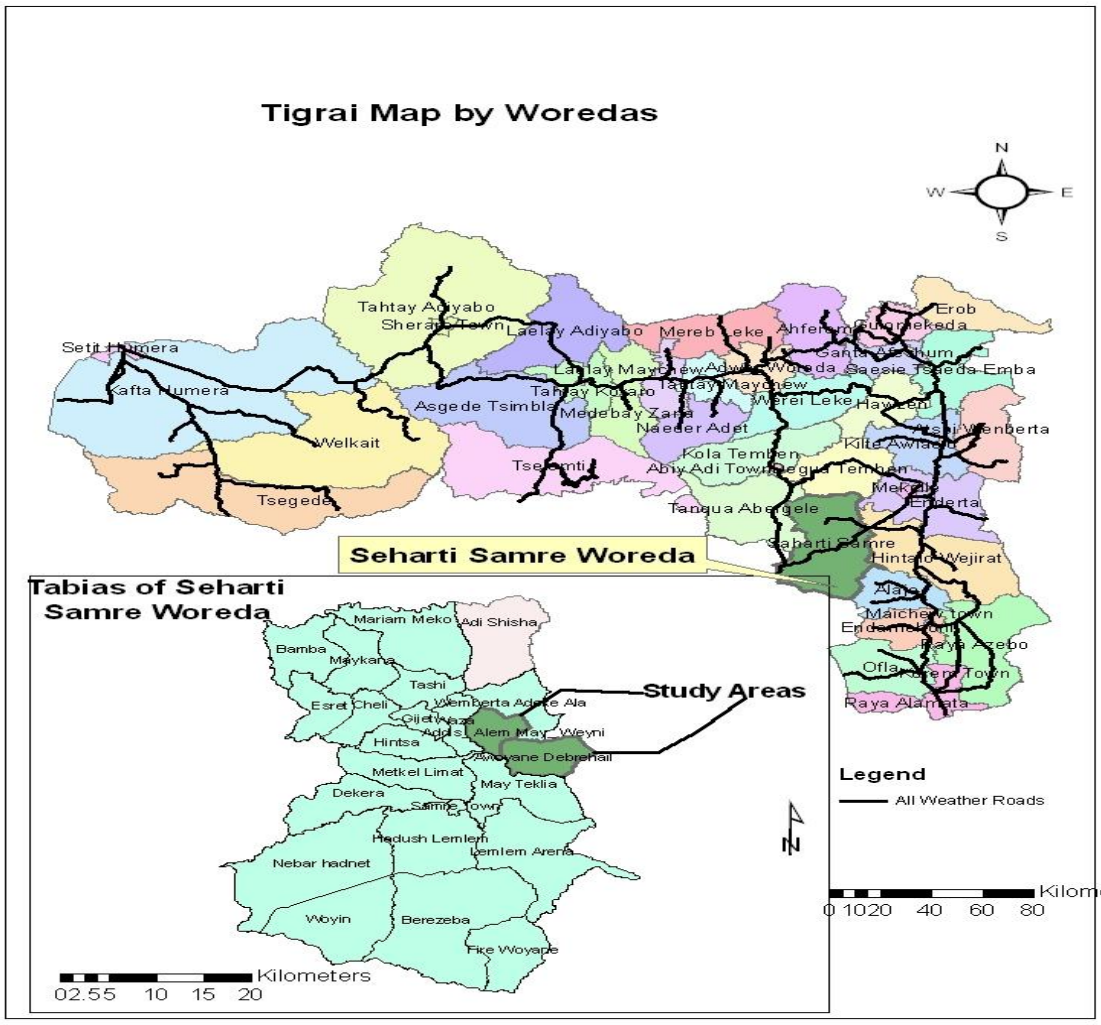
3.2. Socio-economic profile of the study area

Seharti-SamreWoreda is one of the Woreda's in south-east zone, Tigray region. The capital town of the woreda is Samre; found at south west direction of Mekelle at the distance of 60 Km. It extends from13^0 02' 00" to 12^0 30' 00" of North latitude and from 38^0 59' 00" to 39^0 26' 00" longitude (SSOARD, 2010). It has an area of 1716.74$Km^{2.}$ Seharti-Samre district are boundedat the direction of South west with Regional State of Amhara such as with wage-kimera, at North with Degua-Tembien, at West with central zone of Tigray such as Tanqua-Abergelle district, at East with southern zone TigrayAlajie and from south eastern Zone of Tigray with Hintallo-Wajirate and Enderta.

According to SSOARD the total population of the Woreda is 136,767 out of which 68,027(49.7%) are males and 68,740(50.3%) are female comprised in 27478 households 20892 being male headed and the remaining 6586 are female headed. Most of the woreda populations (91.1%) live in rural areas and the remaining 8.1% live in urban areas. The political administration of the district consists of 23 peasant associations (*Tabia's*) and 87 villages (*Kushets*). (SSOARD, 2010)

Most of the population of the area is agrarianand mixed farming is the dominant form of agricultural activity. About 95% of the population in the woreda depends on farm activities and 5% of the population depends on earning from off-farm activities such as petty trading, construction works, food for work on soil and water conservation and other developmental projects, employment as daily laborers and sale of fuel wood. The household income from off-

farm activities for the population is a good options or mechanism for livelihood for households during times of food shortage.According to the Woreda office of agriculture and rural development (OARD,2009/10) the total area of the Woreda is estimated to be about 171,650 ha out of this 35742 ha is cultivated land, 36,782 ha agro forestry, 37,075 ha grazing land and 62,051 ha is miscellaneous land. From the total cultivated land 5520 ha is irrigated land and on this area about 17,135 farmers are benefited. The average farm size of the area is 0.5 ha per household. And the amount of rain fall ranges from 350-700mm /yr.



Source :- (TBoFED, 2010)

Figure: 3.1.Maps of TigrayAndWeredaSehartiSamre

3.3. Background of irrigation user Tabia's

Andi-WoyaneDebrehaila:- is located at an altitude of 2290 m.a.s.l. The total area of Andi-Woyanedebrehailatabia is 4060.87 hectares. The cultivable land is 1466.5 ha (36.1%). There is no rainfall gauge in the tabia, so only the estimated average rainfall ranges from 500-747 mm.The soil types are 55% vertisols (black soils), 10% luvisol(red soils) and camisole (bole soils) 35%.In A/W/Debrehailatabia a total of 100 ha is irrigated benefiting 768 farmers.

Addis-Alem: - is located at an altitude of 1700-2200 m.a.s.l. The total area of Addis-Alemtabia is 3440 hectares. The cultivable land is 914 ha (26.5%). There is no rainfall gauge in the tabia so only the estimated average rainfall ranges from 550-750mm. The soil types are 65% vertisols (black soils) and 35% luvisol (red soils). In this Tabia, a total of 121 ha is irrigated benefiting 1098 farmers. (Tekleyohans, 2010)

3.4. Methodology

3.4.1. Selection of the study area

The study was conduct in two kebelles of Samreworeda:Amdiweyanedebrehayla and AdissAlemkebelles. The study woreda aswell as the Kebelles were chosen because of the following reasons

*Thekebelle are located at the highlands of the region and they have relatively high population densities, and water potential.

*Farmers in the area have long history of traditional irrigation practices as compare to other areas.

*The kebelles have relatively better irrigation activitiesthat give opportunity to government in developing modern small-scale irrigation schemes. In this area, in addition to seventeen traditional schemes, six modern (2 Micro-dam and 4 Diversions) small-scale schemes were constructed in the district and are operational. So it is better to check the income difference among users and non-users in order to motivate non-users to use any water resource options.

*Finally the kebelles are accessible in terms of road, market etc.

3.4.2. Sampling Techniques

In this study, a two stage simple random sampling procedure was adopted for the select sample respondents. In the first stage, twotabias were selected out of a total of 23tabias in the woreda based on the current practice and potential for irrigation, and their accessibility in terms of road. In the second stage, a list of all farmers in the two tabias was obtained and stratified into two irrigation users and non-users. A total 130sample households (78 irrigation users and 52 non users)wererandomly selected from the list. The sample size was distributed to each group proportionate to the population in each category. Abe 1 below shows the distribution of the sample by tabia and irrigation use.

Prior to the actual survey, preliminary information was obtained from tabia administrators, office of agriculture and rural development, community leaders, key informants and development agents in order to have a good understanding about the study area and to get information for the study. To increase data validity and reliability, qualified enumerators were hired. The enumerators were given training and close supervision was made at the time of data collection.

Table:3.1. Sample households by kebelle

District	Sample *Tabia's*	Number of irrigation user HH		Number of non-irrigation HH		Total Number of sampled HH
		Total HH	Sample HH	Total HH	Sample HH	
Seharti-Samre	A/W/Debrehaila	768	37	453	23	60
	A/Alem	1098	52	407	18	70
Total		1866	89	860	41	130

Source: -From two TabiaOARD 2011/12

3.4.3. Data Collection mechanisms and types of data

Both primary and secondary data were used in this study. To obtain primary data, structured questionnaire with both closed and some open-ended question was developed. Important variables on economic, social and institutional aspect of the society in the sampled *Tabia's* were collected. Two enumerators, both from the sampled *Kebeles*, were recruited. Necessary care was taken in recruiting the enumerators and strict supervision was made during the course of survey work. The enumerators are allfluent speakers of the local language, (Tigrigna).the enumerator were given intensive training ondata collection procedures**,** interviewing techniques and the detailed contents of the questionnaire. The structured questionnaire was translated to (Tigrigna) to allow enumerators better understand the questions and properly administer the interviews.

The questionnaire was pre-tested and adjusted accordingly before and after normal interview. Then using the amended structured interview schedule, primary data were collected by using personal interview technique from sampled farmers. In addition to this the study was supported by photograph on specific and interesting issues. The survey work for the collection of primary data was done in the month of December 2012.

Secondary data were collected from different sectors such as from Regional Bureau of Water Resource, Mining and Energy (MWRME), Tigray Bureau of Finance and Economic Development (TBoFED), particularly from Bureau of Agriculture and Rural Development (BoARD).Moreover, secondary data were obtained from documents of the line officesof District Offices of Agriculture and rural development (DoARD), District Offices of Finance and Economic Development (DoFED), are also some of the data sources for secondary data that were obtained.

3.5.Method of Data Analysis

3.5.1. Descriptive Analysis

To assessment and analysis the impact of irrigation on house hold income and poverty alleviation, both descriptive analysis and econometric models were employed. The descriptive analysis was made using frequencies, means, percent, maximum and minimum values of some important variables. Econometric models were used to estimate the relationship between the variables (dependent and independent variables) using the propensity score matching and linear regression.

To compare the levels of poverty among irrigation users and non-users, the three measures of poverty index developed by Foster et al. (1984) were used.

3.5.2. Econometric Model

It was hypothesized that irrigation is expected to have immediate effect on cropping intensity resulting in larger production, higher income and poverty reduction from both crop outputs, trading of outputs and inputs. To be specific, irrigation user households will have higher income and consumption expenditure than the irrigation non-user households.

Propensity score matching model was employed to estimate the income difference of households between irrigation users and non-irrigation users (rain fed users only).

3.5.3. Impact Measurement using Propensity Score matching method

The propensity score is defined by Rosenbaum and Rubin (1983) as the conditional probability of receiving a treatment given pre-treatment characteristics:

$$P(X) \equiv Pr\{D = 1|X\} = E\{D|X\}. \quad (1)$$

Where $D = \{0, 1\}$ is the indicator of exposure to treatment and X is the multidimensional vector of pre-treatment characteristics. Rosenbaum and Rubin (1983) show that if the exposure to treatment is random within cells defined by X, it is also random within cells defined by the values of the mono-dimensional variable p(X). As a result, given a population of units denoted

by i, if the propensity score p(Xi) is known the Average effect of Treatment on the Treated (ATT) can be estimated as follows:

$$\tau \equiv E\{Y1i - Y0i|Di = 1\} \quad (2)$$
$$= E\{E\{Y1i - Y0i|Di = 1, p(Xi)\}\}$$
$$= E\{E\{Y1i|Di = 1, p(Xi)\} - E\{Y0i|Di = 0, p(Xi)\}|Di = 1\}$$

Where the outer expectation is over the distribution of (p (Xi) |Di = 1) and Y1i and
Y0i are the potential outcomes in the two counterfactual situations of (respectively) treatment and no treatment.

In recent times, matching is a non-parametric method that is widely used in the impact evaluation literature (Cobb-Clark and Crossley, 2003; Heckman et al., Ravallion, 2005). Matching methods aid in creating a counter factual from the control group. The basic assumption when using a counter factual is that the untreated samples approximate the treated samples if they had not been treated, i.e., (y_{0i} /I=1) (Heckman et al., 1998).For the matching method to be valid, the assumption of conditional independence (CIA) is critical and must hold true. The CIA argues that treatment is random and conditional on observed variables(x) specified as:

$$(Y_1, Y_0) \perp I/x \quad (3)$$

This assumption implies that the counter factual outcome for the treated group is the same as the observed outcomes for the non-treated group given the control variables(x). In the present case, this means that the counterfactual income is the same as the income level that would have existed if the household had no access to irrigation, specified as:

$$E(Y_0/X, I=1) = E(Y_0/x, I=0) = E(Y_0/x) \quad (4)$$

The first term of equation (4) represents the counterfactual income of the treated group and is equal to the observed income of the untreated (control) group.

This assumption rules of selection in to the program and gains from irrigation on the basis of un observables. The CIA requires that the set of X's contain all variables that jointly influence the outcome with no treatment, as well as the selection in to the program. Under conditional independence, therefore, the average treatment effect on the treated (ATT) can be computed as:

$$ATT = E(Y_1 - Y_0 \backslash X, I=1) = E(Y_1/x, I=1) - E(Y_0/x, I=1) \quad (5)$$

However, matching of households based on observables may not be feasible when the dimension of control variables in large. To overcome this problem of dimensionality, Rosenbaum and Rubin (1983) argued that one can match a long a single index variable given by the propensity score, P(x), which summarizes the multi-dimensional variables.

For the propensity score matching (PSM) to be valid, the balancing properties need to besatisfied**.** It is intuited that two households with the same probability access to irrigation will be placed in the treated (with access to irrigation) and untreated (without access to irrigation) samples is equal proportions. The propensity score is estimated by a binary choice model, which, in this paper, is represented by a binary logit model. Once the propensity score (P score) is estimated, the data is split in two equal spaced Pscore intervals, implying that, within each of these intervals, the mean Pscore of each conditioning variable is equal for the treated and control households, known as the balancing property. Since the Pscore is a continuous variable, exact matching may not be possible, in which case a certain distance between households with and without access to irrigation must be accepted. In the present study, households with and without access to irrigation were, therefore, matched based on their propensity score (Pscore) using the nearest neighbor, Kernel, Radius and stratification matching methods.

These methods identify the closest match for each irrigating house hold (i.e., with the closest propensity score) among households that have no access to irrigation, and then compute the effect of irrigation as a mean difference of household income between the two households. As (Becker and Ichino, 2002) briefly mentioned that there are four types of matching methods as follows. Each type of algorism has theirown strength and weakness. Based on this issue I can use 4 types of algorism. But mostly I need best to usenearest neighbor matching method.

a) **Nearest neighbor matching method**:-each treated observation is matched with an observation in the control group that exhibits the closest propensity score. In nearest neighbor matching, it is possible that the same household in the control group can neighbor more than one household in the treated group. Therefore, after matching, the difference between their

incomes is calculated as the average effect of access to irrigation on household income (ATT).

b) **Kernel matching method**:-all treated observations are matched with households in the control group based on the weighted average that is inversely proportional to the distance between the propensity scores of the treated and control groups.

c) **Radius matchingmethod**:-is each treated unit is matched only with the control units whose propensity score falls in a predefined neighborhood of the propensity score of the treated unit. If the dimension of the neighborhood (i.e. the radius) is set to be very small it is possible that some treated units are not matched because the neighborhood does not contain control units. On the other hand, the smaller the size of the neighborhood the better is the quality of the matches.

d) **Stratification matching method**:-the data set is divided in to intervals having, on average, the same propensity score. The treated and control groups within that intervals are placed under one block, and the mean difference of the outcome between the treated and control groups provides the average treatment effect of irrigation on household income(ATT). In this study the hypotheses research is described as follows.

Null hypothesis (H_o): There is no income difference between irrigation users and non-irrigation users.

Alternate hypothesis (H_1):There is income difference between irrigation users and non-irrigation users. Access to irrigation improves household's income.

3.5.4. Poverty Profile Measurements

According to Sen (1976: 219-59), the measurement of poverty involves two distinct problems. The first problem involves identifying a poverty line and identifying the poor. The second challenge is regarding the construction of a poverty index that measures the intensity of poverty suffered by those below the poverty line. These problems have attracted considerable attention from economists (Ravallion, 1998; Kakwani 1980; 1986; Foster et al., 1984).

There are a number of conceptual methods for estimating the poverty line. The three most common approaches are: the Direct Calorie Intake (DCI) Approach, the Food Energy Intake (FEI) Approach and the Cost of Basic Needs (CBN) Approach. These methods differ in terms of their approach, to estimate the threshold or poverty line.

The direct calorie intake method to measure poverty, considers as poor, any household not meeting the minimum nutritional requirement that satisfies basic human consumption needs for good health. The second approach is food energy intake approach: the premise of this method is to find the actual value of per capita consumption at which a household can be expected to fulfil its caloric requirement; this means that the poverty line is defined by the level of per capita consumption at which people can be expected to meet this nutritional requirement. This represents a methodological improvement in terms of representativeness because the food energy intake method provides a monetary rather than purely nutritional concept of poverty. However, the method suffers from major deficiencies in terms of overall consistency.

In current literature, the most popular method of estimating poverty lines is the Cost of Basic Need (CBN) method. The CBN approach is anchored on estimating the cost of attaining a predetermined level of food energy or calorie intake requirements and also meeting other basic none food requirements.

3.5.5. Measuring Poverty Index

To compare the levels of poverty among irrigation users and non-users, the three measures of poverty index developed by Foster et al. (1984) was used. These poverty measures P_α are based on the following equation:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{M}\left[\frac{(z - y_i)}{z}\right]^\alpha \qquad \text{eq(1)}$$

Where

z is the poverty line,

y_i. is the consumption expenditure (standard of living) for individual i,

N is the number of people in the population, and

M is the number of people in poor households.

α is a parameter reflecting the weight placed on the very poorest individuals.

When $\alpha = 0$, equation (1) this gives the incidence of poverty, is also called as the head count ratio or head count index. This is defined as the percentage of people falling below the poverty line and is currently the most commonly used measure of poverty index (Ravallion, 1996, Deaton, 1997).If a household spends below a pre-defined level it is considered to be poor.

The poverty head count index measures the proportion of families actually living below the poverty line. The head count index is helpful since it allows one to calculate the marginal impact of additional spending, outputs on the number of people lifted out of poverty (Revallion, 1996). A problem with the head count index is that it ignores concerns about the distribution of income among the poor. This index does not take into account a major implication of the policy: those who were initially further below the poverty line that have since possibly become destitute. Also, the families who moved above the poverty line were those among the poor who were possibly least in need of help. Consequently, Foster-Greer-Thorbecke developed the poverty gap index and the poverty severity index (square poverty gap index).

If the equation $\alpha = 1$ it refers to the depth of poverty and called the Poverty Gap Index. This measures how far poor individuals are from the estimated poverty line. It helps to provide information on the cost or budget required to lift all the poor out of poverty. This measure captures the mean aggregate consumption shortfall relative to the poverty line across the study group population. Individuals above the poverty line have a zero poverty gap. When $\alpha = 2$, the equation shows a measure called the Severity of Poverty Index (or Squared Poverty Gap). Severity of poverty index takes into account the distribution of poverty amongst the poor and places greater weight on those furthest away from the poverty line rather than the poverty gap index. Therefore, it shows not just how many people are poor and how poor they are, but also the degree of income inequality among poor households. For example, if a poor individual receives an income transfer from a much poorer one (with both of them still below the poverty line), neither index would change. From this index's I will use one of them for the study to show does the irrigation have an impact on the poverty reduction of the study area.

3.5.6. Definition of Variables and Hypothesis Setting

3.5.6.1. Definition of determinants of household income

In the estimation of the impact of irrigation on household income the dependent variable is the annual household income which included both agricultural (farming and non-farming) and non-agricultural off-farm incomes. The non-agricultural or income obtained from off-farm activities was considered because, income that could be obtained from irrigation activity can be compensated by nonagricultural or off farm activities. The contribution of irrigation to household income might be exaggerated if the inclusion of non-agricultural or income obtained from off-farm activities is ignored. It means that if the household income from non-agricultural or off farm activities is omitted and only agricultural income is considered the share of income obtained from irrigation activities might be higher than when income from both agricultural and non-agricultural or off farm activities are considered.

The income of a household is determined by a wide variety of technical and social factors. The technical factors in crop production include mainly land topography and type of input used. Among the social factors, individual and family characteristics are quite important. Based on theoretical relationship and other similar empirical studies, the following explanatory variables were hypothesized to explain the household income. The relationship between each explanatory variable with income is discussed as below.

Age of the household: -this is refers to the age of the sample household who participant in irrigation and non-participated in irrigation**.** It hypothesize that there is positive relationship between age of a household and income.

Family size of the household:- The availability of large family size helps the members to contribute more in management of agricultural output. Thus, it is hypothesized that a household with large family size in adult equivalent is expected to have higher income

Gender of household:-is a dummy variable for gender of household head 1 for male and zero for female headed household. Sex of the household is important thing in the agricultural production. Male headed household is more likely to adopt modern agricultural system than female headed household; it is expected male headed household would have higher annul income as compare to female headed household and it expected to have positive coefficient.

Total cultivated land:-This refers to the total area of farmland that a farm HH cultivated in hectares. In agriculture, land is one of the major factors of production. The availability of cultivable land enables the owner to earn more agricultural output, which implies more income. Therefore, land holding and improvement in the income level are expected to have positive relationship.

Amount of fertilizer used:-The use of fertilizer will increase the productivity of a given land. Improvement in productivity will ultimately lead to improvement in income level. Thus, it is hypothesized that a household using higher fertilizer amount is expected to have higher income.

Education level of the household head:-four dummy variable for educational level of a household were included in the model, read and write, attend primary school (1- 8 grade), secondary school (9-12 grade) and attend college. Household with not able to read and write (illiterate) was taken as a reference category. It is expected that higher educational level of household would have a positive contribution enhances farmers' ability to perceive, interpret, and respond to new events and technologies in the context of risk. Education is, thus, hypothesized to increase the probability of farmers' adoption of new technologies and hence increases household income.

Access to irrigation:-a dummy variable for access to irrigation plot was includes in the model and none irrigation users were consider as benchmark category. Thus, it was hypothesized that households' access to irrigation plot would increase household income via increase crop and land productivity through adoption of yield enhancing input, increasing frequency of harvest and crop intensity.

3.6. Theoretical Framework of Impact of Irrigation on Poverty

The development and utilization of water resources in agriculture through irrigation development creates an economic environment that has direct and indirect benefits for the local and national economy. However, many discussions of irrigation benefits have focused on direct production effects such as increased crop yield and farm income. The debate often ignores a much wider array of benefits ranging from increased labor demand and the creation of new opportunities for non-irrigation water use. Furthermore the economic impacts such as decreases in food prices and other economic multipliers effects associated with the provision of irrigation are also significant (Hussein, 2007).Hussein also notes that the direct and indirect benefits of irrigation vary greatly across systems, and are dependent on a range of factors that include local conditions, system management, irrigation policy, and broader economic and political factors. The indirect irrigation benefits are larger, and often substantially larger, than the direct benefits; and the distribution of irrigation benefits varies greatly by type of benefit and socioeconomic status. He classified the benefits of irrigation into five typologies:

Type 1: direct benefits related to expansion in employment from construction, rehabilitation and maintenance of irrigation systems.
Type 2: direct benefits related to irrigation-induced expansion in crop productivity.
Type 3: localized indirect benefits related to productivity such as increases in employment, wages, income generation and consumption in local communities.
Type 4: other localized benefits from multiple uses of water such as livestock watering and use of water for household chores;
Type 5: broader-level multiplier benefits from the linkages with non-agricultural sectors, (tekleyohans, and 2010)
Hence, it simplifies the analysis of linkage between irrigation and poverty at household and community level. The assumption in this thesis is that access to reliable irrigation has a positive impact on overall poverty reduction of a household.

The overall working hypothesis with respect to the impact of irrigation on poverty, is expressed as follows

H_o : there is no difference in poverty incidence(head count and severity of poverty) between irrigation uses and non-irrigation users.

H_1: There poverty incidence difference between irrigation users and non-irrigation users

Increased in availability of irrigation in dry land areas has a significant effect in increasing productivity of the land through intensive use of agricultural inputs; thereby contributing to increased household income and poverty reduction.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1. Socio-economic Characteristics of the Sampled Households

In this section, the sample households' demographic and community characteristics are discussed so as to understand the various characteristics among the study groups. Particular reference is given to family size, education level, land holding, sex of the household, and access to irrigation. Such analysis is important to ensure an understanding of the context in which the results were obtained.

Age of the household: - is one of the household's personal and demographic characteristics and measured by years. Although Old people have more experience in traditional irrigation but they are not flexible enough to adopt new technology and farming practices which modern irrigation agriculture demand. Therefore, as age advances household heads become much reluctant to accept new production styles and technology. Survey result indicate that age of respondents ranged from 23 to 80 years for both irrigation and non-irrigation users averaging at 46. There is some age difference between the two. The mean age of non-irrigation users is 47 and that of irrigation users is 45 years. Although the mean age of non-users slightly exceeds the mean age of users, the difference is not statistically significant.

Table: 4.1. Age of respondents in each category

Group of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	45.73	1.512112	46.33846	t= 0.7905*
Non Irrigation Users	47.25	1.202682		

Source: Sample survey 20011/12

Gender of household: - male headed households are more likely to adopt modern irrigation system than female headed households. Since women in the study area like all other women in the country have triple responsibility of female's in production, reproductive and childcare, and also they have less access to information about the technology. It is expected that male headed household easily adopt improved irrigation system than their female headed counterparts. Among the 130 sample observations only 12.3% are females and the remaining 87.7% are males. Out of the total surveyed household, only 78 respondents reported had access to irrigation, out of this 19.2% females were irrigation users; the chi-square test revealed that the difference is statistically significant at 1% level of significance.

Table: 4.2. Sex of the Survey Respondents

Sex of Sample Household	Number Male	Number Female	Total number	(P value)
Irrigation Users	63	15	78	0.003***
Non Irrigation Users	51	1	52	

Source: Sample survey 20011/12

Family size of the household: - Households who have large family size is more likely to manage properly irrigation practices rather than households with less family size, because the availability of large family size helps the members to contribute more in management of irrigation activities. Therefore, family size of a household head has direct relationship with adoption and intensity of modern irrigation activity. As the result explained below, the average family sizes in the study area are 4 persons; also the minimum and maximum family size of the sample house hold is 1 and 11 respectively. The number of family members involved on agricultural activity ranges from 1 to 5. The average family size of irrigation users and non-users are 4 and 3 respectively. And also it is statistically significant at 1% level of significance.

Table: 4.3.Family size of respondents in each category

Group of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	4.5	0.162	4.153846	t= -3.1597***
Non Irrigation Users	3.63	0.195		

Source: Sample survey 20011/12

Farm Size and Land holding:-In an agrarian society like Ethiopia, ownership of land, particularly cultivated land as well as ownership of livestock is referred to as productive assets. These assets are a prerequisite in the productive activities for agricultural production. As participants in the focus group noted land size and land fertility are the most important factors for differences in agricultural production and wealth disparities between households. The research then seeks to examine whether land holding per household vary among the sample study areas and household land holding size has relationship with household access to irrigation pilot. The survey result on table 4.4 indicates that the average household land holding size for surveyed household was 1.25 hectare (five tsimad), which is slightly more than the holding which is 1.02 hectare (TBoFED, 2010).The average land holdings of non-irrigation and irrigation users were 0.99 hectare (4 tsimad) and .75 hectare (3 tsimad) respectively and this difference is statistically significant at 1%. That is, irrigation users possess less land on average than non-users.

Table: 4.4. Farm size (Land holding) of Respondents in each category

Group Of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	.7553	.0630536	.8524954	t= 3.3867***
Non Irrigation Users	.9981	.0407514		

Source: Sample survey 20011/12

Amount of fertilizer used:-The use of fertilizer increases the productivity of a given land and hence increases household income. Survey results indicate that irrigation users use more fertilizers than non-users. The average use of fertilizer for irrigation user is 1.173quintal while for non-irrigation user household is found to 0.7999 quintal and the difference is statistically significant at 1% level of significance.

Table: 4.5. Amount of fertilizer used Respondents in each category

Group of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	1.17	0.078	1.023769	t= -3.7557***
Non Irrigation Users	0.78	622203		

Source: Sample survey 20011/12

Educational level: - Education level of the respondents on the study area,the result indicated that out of 78 irrigation users 53.85% were not attend any schooling neither read nor write, while 21.8% of them could read and write but without a formal education and 16.7 % of them participated on irrigation practices had complete a primary school education and 7.7% had not complete a primary school education. Out of 52 non- irrigation users 40.4% were not attend any schooling neither read nor write respectively, while 13.5% of them could read and write but without a formal education and 44.2% of the respondents complete a primary school education; very few respondents had not complete a primary school education. The chi square test shows that education level is statistically significant at 1 % level of significance.

Table: 4.6. Educational level of respondents

Highest Level Of Education	Irrigation User	Non-Irrigation	Total Number
Never schooling	42	21	63
Religious or traditionally schooling	17	7	24
Primary schooling incomplete	6	1	7
Primary schooling complete	13	23	36

Source: Sample survey 2011/12

Access to Extension Services

The study result showed that 66.9 % of the sample households get extension service. When we compare irrigation user and non-user households' majority of the user households get support from extension agents when compared to non-users. According to the survey 67.9 % users and 65.4% non-users get extension service. Extension service here refers to advice, training, demonstration and distribution of input. Extension agents in the study areas reported that there is a program of training and orientation to irrigators and rain fed cultivators on various subjects. Shortage of extension agents at kebelle level remains a problem in all study areas. In 2011/12, three or four extension agents per kebelle were working to provide technical assistance, but it was found that they were not adequately supplied with sufficient transport facilities to provide adequate support. The survey result indicates that 32%of users and 34.6% non-users do not get extension service. The farmers receive service 2-3 times per season. The average number of days of extension service for irrigation user is 2.42 days and 2.38 days for nonuser. Irrigation practice requires close follow up to aware farmers in order to use input and technical service. But in practice in the ground reality the result shows that extension service is not significant difference among users and non-users.

Table: 4.7. Extension service user on each category

Did you gate extension service	Accesses of irrigation(%)		Total
	User	Non user	
Yes	53/87	34	87
No	25	18	43

Source: Sample survey 2011/12

Table: 4.8 Extension service frequencies

Group Of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	2.423	0.0845951	2.406977	t = -0.3718*
Non Irrigation Users	2.382	0.0691805		

Source: Sample survey 2011/12

4.2. Contribution of Irrigation on Farmers' Livestock Holding

In a mixed agricultural system livestock are kept primarily to serve as a source of oxen power and secondly as a source of heifers for replacement stock and for milk production. Household with large number of livestock will not face draught power constraint and increases the possibility of maximizing output. Moreover, in cases where households own more number of livestock which could mean more number of oxen than they require, can hire or lease-out oxen so that households generate income from the lease. Moreover, households that have got large number of livestock can fatten those that are not immediately used for draught power, replacement and milk production and hence generate additional income. Therefore, the number of livestock owned by a household will have direct relationship with improvement in income level. Irrigation services as one of the technology options available, enables the farmers to diversify their production and apple them to

have a large number of livestock ownership as camper to the non- irrigation users. In doing so, it helps the farmer to increase production and income. Therefore, it was hypothesized that irrigation activities have a positive impact in increasing the number of the livestock ownership. From the result the irrigation user have more owner ship than those who doesn't the average livestock holding in tropical livestock unit (TLU) for irrigation user is 4.12and 3.01 non user. The difference is statistically significant at 1 % level of significance. This shows that irrigation activity has a direct impact on the livestock holding which is in household income and living standard.

Table: 4.9.Livestock owner sheep of respondents

Group of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	4.124	0.3008	3.6815	t = -2.5941***
Non Irrigation Users	3.0173	0.2632		

Source: Sample survey 2011/12

4.3 Food and Non-Food Expenditures of Irrigation User and Non User

The aim was toexamine the magnitude of change which had occurred in the annual consumption expenditure by estimating the difference between irrigation users and non-irrigation. The average household's total consumption for the study areas was estimated using the monthly food expenditure per adult which includes food and non-food expenditure. According to the survey, food expenditure for irrigation users was ETB 283.83 and for non-users it wasETB 210.765 and the difference is statistically significant at 1 % level of significance. The non-food expenditure for irrigation users is higher than the non-user it wasETB 48 for users and ETB 41.75 for non-users. But, the difference was statistically insignificant.

Table: 4.10. Food expenditures on both categories

Group Of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	283.83	27.28	254.6167	t = -1.9864**
Non Irrigation Users	210.78	18.69		

Source: Sample survey 2011/12

Table: 4.11. Non-Food expenditures on both categories

Group of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	48.028	5.76	45.52	t = -0.8606**
Non Irrigation Users	41.752	2.21		

Source: Sample survey 2011/12

4.4 Propensity Score Matching Estimates of the Irrigation impact

To examine the impact of irrigation on household income further analysis was done using Propensity score matching model econometric modeling. to generate propensity score first analysis on decision to participate in irrigation was done by regressing variables that affect participation of irrigation but does not affect income of the household which means that the explanatory variable affects the dependent variable but does not the outcome. The logit estimates of propensity score (pscore) are presented inTable 11with the help of STATA program output.

Table 11 reports the empirical evidence on the average treatment effect of irrigation on household income using nearest neighbor, radius and the kernel matching estimator. Column 1 indicates the type of matching estimator, column 2-3 shows the number of treated and control

groups, column 4 represents the estimated average gain of income mean as a result of access to irrigation after matching, and Column 5-6 shows the estimated bootstrap standard errors and T- statistics. The t statistics were based on bootstrapped standard errors with 200 replications which were used to verify whether the observed effect was significant or not.

Using nearest neighbor and kernel matching the average gain of income per adult on the treated group was ETB 2724.18 and ETB 650 respectively. This difference was statistically significant with p-value <0.01 percent. Using a radius matching method the average treatment effect gain as a result of irrigation was estimated at ETB 1357.95.but, this difference was not statistically significant. In general using both matching methods, irrigation user households have significantly higher income per adult compared to the non-irrigation user households. This suggests greater benefits are gained by irrigation activity which helps beneficiary households to gain an increased income from cash crop farming activities. This increased income in turn leads to higher household consumption expenditures and an increase in household welfare. The study confirms that irrigation development has a significant contribution in improving household welfare.

Table: 4.12. Estimate PSM to Measure Impact of on irrigationHousehold income

Type of Matching Methods	Number Of Match		Average gain of Income (ATT)	Bootstrap Standard Error	T-Test
	Treated (irrigation user)	Control (non-user)			
Nearest neighbor	78	28	2724.18	600.31	4.33***
Kernel	78	41	650.7	120.73	5.39***
Radius	24	48	1357.95	956.7	1.4*

Note: *** significant at P<0.01

4.5 Impact of Irrigation on Poverty Reduction

Household income or consumption expenditure data canuse as one means to compare the welfare level and the poverty level among households. However, in developing countries consumption is typically preferred over income as the former better captures the welfare level of a household. This is mainly due to the fact that households are likely to under report their income than they do their consumption level (Ravalion, 1998). Thus, to determine the actual impact of the irrigation on poverty, the expenditure approach was used and the total expenditure was estimated separately for users and non-users. The table below compare that headcount, poverty gap and poverty gap squared for users and non-user and the estimated poverty line taken was 165 for food poverty and 315 for total poverty.

Table: 4.13.The estimated poverty line

Group of Sample Household	Food Poverty Level			Total Poverty Level		
	P(0)	P(1)	P(2)	P(0)	P(1)	P(2)
Irrigation Participant	0.128	0.013	0.00025	0.012	0.021	0.007
Non Participant	0.170	0.052	0.029	0.442	0.091	0.027

Source: Sample survey 2011/12

From the study area the incidences of the food poverty of the participant in terms of the head cont. is 12.8 % and 17%for the nonparticipant. Poverty gap of the sampled household is 1.3 % for participant and 5.2 % for non-participant. The poverty severity of the sampled householdis for the participant 0.025 % and for nonparticipant 2.9 %. Using asimple t test the irrigation user has higher monthly per adult consumptionexpenses than those non irrigation users.Monthly consumption expense per adult for irrigation user is ETB 331.85 and ETB 252.54 for non-irrigation user. Themean difference between the two is statistically significant at 5 % level of significance. This result shows that irrigation users are less poor as compared to non-users.

Table: 4.14.Total consumption of the household

Group of Sample Household	Mean	Standard Error	Mean Difference	t-value
Irrigation Users	331.85	31.22	300.13	t = -1.9087***
Non Irrigation Users	252.54	19.78		

Source: Sample survey 2011/12

4.5.1 Impact of Irrigation on Household Consumption Expenditure

Household income or consumption expenditure data has been used as one means to compare the welfare level among households. In this section the OLS regression model were used to indicate if irrigation activity significantly explains consumptionexpenditure of household. Households that have irrigation access have high consumption expense than those household who don't have irrigation access. This relationship between consumption expenditure and access to irrigation is statically significant at 1% level of significant. This suggests that a relatively better quality of life was evident for irrigation users when compared to non-irrigation user households.

Table: 4.15.Total monthly consumption of the household in each category

Total consumption	Coef.	Standard error	t-value	p> | t |
Log age	557.236	265.25	2.10	0.038
Log family size	272.3557	184.3921	1.49	0.142
Log live stock	231.0213	99.45	2.32	0.022
Log land	57.51355	139.45	0.41	0.690
Accesses to irrigation	396.1134	119.1187	3.33	0.001
Education dummy 2	-170.74	143.66	-1.19	0.237
Education dummy3	-57.30	2333.92	-0.24	0.907
Education dummy4	150.01	137.46	1.09	0.277
gender	-255.67	185.45	-1.39	0.171
cons	-1416.98	934.62	-1.52	-3268

Source: Sample survey 2011/12

4.6 Opportunities and Challenges of Irrigation

4.6.1 Irrigation opportunities

Irrigation contributes have its own role in increase income and reducing povertybeside that on the long run by integrating with other income generating practiced succeed the food security targets. From the study area there are factors that have a good contribution to practice irrigation activity. As observed on the ground and respondents response indicated that the irrigation opportunities in the study area describes as a good opportunity such as have access of small scale micro-dam 39.74 % which is the main important factor to practice irrigation activity, 6.41% have fertile land, 24.36 % supported by Woreda and Tabia OARD, 6.41% have water manage committee, 8.97% local by law and provided instructive support, 12.82% access of micro dam and support by TOARD and local by law. All this factors have appositive contribution in practicing irrigation activity by increasing production capacity and in turn increase income of the household and living standard.

Table: 4.16. Major irrigation opportunities

Opportunity To Irrigation	Frequency	Percent	Cum.
Access Of Dam Water	31	39.74	89.74
Have Water Management Committee	5	64.41	52.26
Supported By Wereda and Tabia OARD	5	24.36	58.97
Provided Instructive Support By Local By Laws	2	2.56	83.33
Access Of Micro Dam And have local by low	2	7.69	85.9
Access Of Micro Dam And Support By TOARD	4	5.12	93.7
Have local by law	5	6.41	98.7
Have fertile land	5	6.41	46.15

Source: Sample survey 2011/12

4.6.2 Constraints of irrigation practices

Constraints and cause of conflict in irrigation development

There are a lot of economic and environmental problems faced to irrigation development throughout the regions particularly in our study area. The increased dependence on irrigation has not been without its negative environmental effects. In adequate attention to factors other than the technical engineering and projected economic implications of large-scale irrigation or drainage schemes in Africa has all frequently led to great difficulties (FAO, 1997).

In the study area also there was irrigation conflict and constraints between irrigation users. there was no clear regulation and policy regarding using water and utilization; this being a considerable source of conflict among adjacent ground water users for irrigation. Causes of the irrigation conflicts were 37.18 % through theft of water out of turn and 12.82% caused by water scarcity due to declining of water supply from the source, 19.23 % water scarcity due to increasing number of user, 16.67% over use of water like flood and 14.10 % other constraints. In the study area thoseconstraints havetried to allocate through conflict resolution methods through discussion at field level involving irrigators, local elders and development agents at office of Agriculture and rural development.

Table: 4.17. Irrigation conflicts and constraints

Major Irrigation Constraints And Conflicts	Freq.	Percent	Cum.
Theft of water out of turn	29	37.18	37.18
Water scarcity because of declining of supply of water from the source.	10	12.82	50.00
Water scarcity because of increasing number of users	15	19.23	69.23
Over use of water like flood	13	16.67	85.90
Other	11	14.10	100
Total	**78**	**100.00**	

Source: Sample survey 2011/12

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATION

5.1 CONCLUSIONS

Ethiopia is the second most populous country in sub-Saharan Africa (SSA) (and third on the continent) population approaching 80 million and 85% dependent on agriculture and live in rural areas. Agriculture employs 80% of the labor force and accounts 50% of the GDP Agriculture is heavily reliant on rainfall and productivity and production are strongly influenced by climatic and hydrological variability that are reflected as dry spells, droughts and floods. Droughts and floods are endemic, with significant events every 3 to 5 years, with increasing frequency compared to two or three decades ago. Droughts destroy watersheds, farmlands, and pastures, contributing to land degradation and causing crops to fail and livestock to perish.

Although, the majority of cropping in Ethiopia is 'rain fed agriculture' there are four major categories of productive use of water in agriculture: (1) 'rain fed agriculture', (2) 'supplementary irrigation', (3) 'irrigated agriculture', and (4) 'livestock'. It is also important to note the importance of coupling the soil fertility management and nexus of soil-water in the crop production and productivity improvement, Awulachew et al (2005)

Ethiopia also covers 12 river basins with an annual runoff volume of 122 billion m3 of water with an estimated 2.6 billion m3 of ground water potential. This amounts to about 1743 m3 of water per person per year: a relatively large volume. But due to economic water scarcity which is described through lack of water storage capacity and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year with frequent crop failures due to dry spells and droughts. Moreover, there is significant erosion, reducing the productivity of farmland.

Agriculture is by far the dominant sector. Most of Ethiopia's cultivated land is under rain fed agriculture. Less than 40% of the arable area (13.2 million ha, or 12% of the total land area) is currently under cultivation, AfDB (2003). There is progressive degradation of the natural

resource base, especially in highly vulnerable areas of the highlands, which aggravates the incidence of poverty and food insecurity in rural areas. Ethiopia imports about 15% of its food. The government has designed a comprehensive food security strategy that targets the chronically food insecure especially in highly vulnerable areas: marginal and semi-arid areas that are largely moisture deficient, including pastoral areas, with high population pressure. If such measures can be effectively and sustainably implemented, they can make significant difference, Awulachew et al (2005). Improving soil and water conservation is the first action to improve the water supply for agriculture, i.e., making a higher percentage of rainwater that falls onto a field available for plants, Rockström (2000). Water for agriculture is increasingly recognized as a major constraint to improving the lives of the rural poor and is an important component of rural livelihood programs that need to be yet strongly established in Ethiopia.

Agriculture in Ethiopia is highly dependent on rainfall, which is highly erratic and unpredictable. Therefore, the productivity of the peasant agriculture is very low and it is not possible to attain the required food security target of the government and the Ethiopian population as a whole. Because of this, food self-insufficiency becomes a common manifestation in Ethiopia. The productivity of rain fed agriculture is low and it is not possible to contribute to the overall development of the country.

Ethiopian government's working hard on agricultural policies and strategies to improve the income and living standard of the rural population. Part of the on-going debate on how to transform agriculture focuses on improved technology, input levels and credit allocation (Corppenstedt and Abbi, 1996).Currently, government provides special attention for agricultural sector by designing growth and transformation plan to come fastest economic growth throughout the country, and to be able the people food security and improves the living standard at household level and to set the country at middle level economic growth country’s in the world in the next 15 to 20 years.

This plan designed and starts to apply in the whole sectors throughout the country but particularly focused on the area that has been with high rainfall variability and high moisture

deficit to tackle the problem of food insecurity that has persisted for decades. Then, one solution of poverty reduction strategy of the government is the use of supplementary irrigation from either traditional or modern water harvesting structures is considered the primary measure to be taken against the problem. In this direction government of Ethiopia is making serious efforts by allocating a fairly large amount of budget for the development of irrigation structures.

In this study, a two stage simple random sampling procedure was adopted for the select sample respondents. In the first stage, two tabias were selected out of a total of 23 tabias in the woreda based on the current practice and potential for irrigation, and their accessibility in terms of road. In the second stage, a list of all farmers in the two tabias was obtained and stratified into two irrigation users and non-users. A total 130 sample households (78 irrigation users and 52 non users)were randomly selected from the list. The sample size was distributed to each group proportionate to the population in each category.

The quantitative and qualitative data provided in this paper are collected from secondary data source and primary data of questionnaires based survey in the SehartiSamrewereda. Various grey and published literatures are used. The actual and perceived impacts of irrigation on household income and poverty reduction were assessed through interviews with various government bureaus, officials, key informants and communities in the selected area. The survey data were analyzed using both descriptive analysis and econometric model with the help of STATA software (version 12) for the estimation of the impact of irrigation on improving household income and poverty reduction.

In this study, both primary and secondary data were collected. To obtain primary data, structured questionnaire with both closed and some open-ended questions were developed. Important variables on economic, social and institutional aspect of the society in the study area were collected. The study primarily followed quantitative research design. However, in order to facilitate the formal survey, exploratory survey was employed beforehand. Then three-stage random sampling procedure was followed to select sampled households for the study. Two Tabia were selected purposely and 130 farmers were randomly selected using probability proportional

to size sampling techniques from the sampling frame. Both primary and secondary data sources were used. Primary data were collected from both 130 sample households.

The secondary data were collected from different sectors such as from Regional bureau of water resource, mining and energy (MWRME), Tigray Bureau of Finance and Economic Development (TBoFED), particularly from Bureau of agriculture and rural development (BoARD).Moreover, secondary data were obtained through discussions with concerned expertise and officials of line-offices of the respective districts. District Offices of Agriculture and Rural development (DoARD), District Offices of Finance and Economic Development (DoFED), are also some of the data sources for secondary data were obtained.

Different analytical techniques were applied to analyze the available information. Percentage and cross tabulation was used to assess the significance of irrigation management practices. Descriptive statistics such as mean, standard deviation, t-test and chi-square were employed to compare between the independent variables the significant income difference among irrigation users and non-users. Propensity score matching model was employed to analyze determinants of income related variables among irrigation users and non-user households independently and also the FGT and the simple liner regression model also employed to analyze the impact of the irrigation on the poverty reduction. This study analyzed the impact of irrigation on household income and poverty reduction in one purposively selected wereda of South east Zone of Tigray National Regional State. The political administration of the Tigray region consists of 7 (seven) administrative zones 46 districts and about 34 and 12 rural and urban dwellers association, respectively and have over 767 kebelles (BoFED, 2010) and with an area of 56,000Km^2 square kilometers. The zone is characterized by mixed crop-livestock farming.

The result of t-test indicated that household family size, farm size and land holding, access livestock holdings, education level and amount of fertilizer used has positive and significant contributions to household income.The thesis hypothesis is that irrigation has an impact in increasing household income, reducing poverty. Descriptive statistics, poverty profile analysis and matching econometrics modeling approaches were used to analyze the empirical data. To

analyze the constraint and opportunity of the irrigation and economic analysis were also carried out.This study has confirmed the profound role of irrigation development in alleviating poverty and increasing income in Ethiopia. The (PSM) result indicated that, the average income of irrigation users were ETB 4003.21 and their non-irrigation also ETB 797 the average income difference between them was ETB 2720.88, it is also significant at 1% level of significance, and hence there is significant mean income difference between irrigation users and non-users. This income difference between irrigation users and non-users weretested properly by propensity score matching (PSM).

Poverty decomposition results by irrigation type affirm that the incidence of poverty is significantly lower among the sample population from irrigation users (12%) compared with non-irrigation users (17%). Poverty Gap Index was also significantly lower for irrigation user (1%) irrigated plots than non-irrigation user farmers (5%). Furthermore, the estimated poverty severity indices show similar results. This significant impact is mainly due to the access of year-round irrigation activity. Prior to the use of irrigation dry season cultivation was not common, as most farm households participated on food for work activities to fill their food gap, but after the introduction of irrigation farmers started to produce high value horticultural crops, both during dry and wet seasons, which enabled them to create employment opportunities for a considerable number of household family members and created additional labor employment for the local people.

The ability to produce high value and marketable crops also enables these farmers to receive increased cash income, own more productive assets and cover all their basic food and nonfood needs for their family members. The research also concludes that in the study area the assessment describes some of the major irrigation constraints were theft of water 48.33%, scarcity due to declining of water supply 21.67%, and water scarcity due to increasing number of user15%, and the remaining 15% are other constraints. This all problems were encountered to smooth irrigation activity andresin for some parts of land to be out of production.

Moreover, irrigation user had better annual income and livestock ownership as compared to irrigation non-user households. Having access to irrigation had significantly improved the living standards of farming households. Moreover, it was found that there is a room to increase production and productivity of irrigation user and irrigation non-user households at the current levels of resources utilization.

5.2 Recommendations

Based on the above findings of the study, the following implications or recommendation remarks can be drawn for further consideration and improvement of irrigation development in the district in particular and in the country at large. The study revealed that access to irrigation has got a significant and positive contribution to household's income and poverty reduction implying that in a country like Ethiopia, irrigation development is crucial in improving the livelihood of the population. It should, also, be noted that for proper handling and management of the modern small-scale schemes continuous training andtechnical assistance are extended and should be provided for the community. Specially, the culture of sowing unmanageable multiple cropping was the big problem in the study area. But you should not only focus on providing training but also you should require closefollow up on the application of the theoretical skill on their field. Each stake holder moved on the district should create strong integration (bond) among them to improving the final goal of house hold living standard by increasing household's income.

In the study area there were socio-economic and administrative major irrigation problems faced on the irrigation practices. Out of these problems are theft of water out of turn, water scarcity due to declining of water supply and scarcity due to increasing number of user, lack of strong local by-law, have high accumulation silton the dam, unfair water distribution among irrigation users and others. From those irrigation constraints I recommend, for that siltation problem on the dam regional and woreda administrative members should give adequate attention to allocate for the treatment of the upper catchments of the dam. But if they are not treated the catchment the dam is on danger because it is phase out from irrigation practice after few years. For the rest problems it requires strong administrative leadership and scientific technical help could be significant.

As observed from the result in the study area, farmers raised the problem of storageand post-harvest processing mechanisms for their irrigation product due to this quality ofproduct deterioration. According to the field observation and orally free discussion of local irrigation users' were explained that, they sell their products by cheap price during harvest period due to lack of storage and processing facilities. If they are not sold it at current price the product is completely spoiled. Then, for this critical problem, by creating integration between OARD and administration office allocate budget to construct a simple shade to store for short period of time until address to market. In addition to this establish irrigation co-operative to solve the problem of selling their products by unreasonable price.

Extension service is a corner stone of agricultural practices in general particularly for irrigation development. But in practice in the study area it is not significant effect with irrigation and increase households' income. This result indicates that there is a problem of extension service. As respondents response and the result shows that there is in efficient technical assistance and follow up appear on the area. The main issue that government should give emphasis is increasing the number of the extension agents which help to training andgivetechnical assistance for the farmers.

Farmers on the survey were planting mono-crop on irrigation fields, then this is also affect the farmer, because he does not get reasonable price due to flooding of one type of product at the market on the same period. So extension agent and administrative bodies you could aware it the farmer to produce different crops for your benefit. Because if you produce diversify crops you can harvest at different time and at this time there is high demand and low product. Then the farmer can sell at reasonable price and the price encourages the farmer to produce next period in the wide area. There were food self-sufficiency gap on mostly particularly on non-irrigation users. This means the whole house holds does not feed their family year round without external support except some of them. So to fill the food gap it requires strong extension service/ creates awareness on the whole society about increasing their efficiency on using modern technologies and efficient use of water resource options for irrigation activity.

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Appendix-A: PSM Result

```
. attk   totalincom  acceirrigation hhage genderhh educdummy2 educdummy3 educdu
> mmy4 livestopercapita landpercapita familysize3, comsup  bwidth(0.06) boot re
> ps(200) dots

 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method

n. treat.    n. contr.          ATT   Std. Err.            t
        78           41     2449.426            .            .

Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.


Bootstrapping of standard errors

command:      attk totalincom acceirrigation hhage genderhh educdummy2 educdumm
> y3 educdummy4 livestopercapita landpercapita familysize3 , pscore() comsup bw
> idth(.06)
statistic:    attk        = r(attk)
..................................................................................
> ..................................................................................
> ..........................................

note: label truncated to 80 characters

Bootstrap statistics                                Number of obs     =       130
                                                    Replications      =       200

Variable |      Reps   Observed       Bias   Std. Err. [95% Conf. Interval]
---------+-------------------------------------------------------------------
        attk |       200   2449.426   164.1104   583.2449   1299.293    3599.56   (N)
                                                  1376.335    3796.638   (P)
                                                   815.315    3334.745   (BC)

Note:   N    = normal
        P    = percentile
        BC   = bias-corrected
```

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
78	28	2724.186	600.314	4.538

Note: the numbers of treated and controls refer to actual nearest neighbour matches

Bootstrapping of standard errors

```
command:      attnd totalincom acceirrigation genderhh landpercapita livestoper
> capita familysize3 educdummy2 educdummy3 educdummy4 hhage hhagesq1 , pscore()
>  comsup
statistic:    attnd      = r(attnd)
.....................................................................
> .....................................................................
> ........................................
```

note: label truncated to 80 characters

Bootstrap statistics — Number of obs = 130; Replications = 200

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
attnd	200	2724.186	-176.1797	689.1318	1365.248	4083.124	(N)
					1032.129	4060.079	(P)
					1562.658	4595.359	(BC)

Note: N = normal
P = percentile
BC = bias-corrected

```
ATT estimation with the Stratification method
Analytical standard errors
```

n. treat.	n. contr.	ATT	Std. Err.	t
78	50	2122.934	624.008	3.402

```
Bootstrapping of standard errors

command:      atts totalincom acceirrigation genderhh landpercapita livestoperc
> apita familysize3 educdummy2 educdummy3 educdummy4 hhage hhagesq1 , pscore(p)
>  blockid(myblock) comsup
statistic:    atts       = r(atts)
.....................................................................................
> .....................................................................................
> ........................................

note: label truncated to 80 characters

Bootstrap statistics                                    Number of obs    =       130
                                                        Replications     =       200
```

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
atts	200	2122.934	-53.3516	614.711	910.7509	3335.118	(N)
					863.7944	3304.626	(P)
					882.4224	3310.318	(BC)

```
Note:  N    = normal
       P    = percentile
       BC   = bias-corrected

ATT estimation with the Stratification method
Bootstrapped standard errors
```

n. treat.	n. contr.	ATT	Std. Err.	t
78	50	2122.934	614.711	3.454

```
. attk    incomepecpita  acceirrigation hhage genderhh educdummy2 educdummy3 ed
> ucdummy4 livestopercapita landpercapita familysize3, comsup  bwidth(0.06) boo
> t reps(200) dots
```

The program is searching for matches of each treated unit.
This operation may take a while.

ATT estimation with the Kernel Matching method

n. treat.	n. contr.	ATT	Std. Err.	t
78	**41**	**650.702**	**.**	**.**

Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.

Bootstrapping of standard errors

```
command:      attk incomepecpita acceirrigation hhage genderhh educdummy2 educd
> ummy3 educdummy4 livestopercapita landpercapita familysize3 , pscore() comsup
>  bwidth(.06)
statistic:    attk       = r(attk)
.....................................................................
> .....................................................................
> ........................................
```

note: label truncated to 80 characters

Bootstrap statistics — Number of obs = **130**; Replications = **200**

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
attk	**200**	**650.7021**	**6.374505**	**120.7291**	**412.6295**	**888.7748**	(N)
					442.6207	**930.3058**	(P)
					442.9727	**943.6263**	(BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Kernel Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
78	**41**	**650.702**	**120.729**	**5.390**

```
. attnd   incomepecpita  acceirrigation   genderhh landpercapita livestopercapi
> ta familysize3 educdummy2 educdummy3 educdummy4 hhage hhagesq1, comsup boot r
> eps(200) dots
```

The program is searching the nearest neighbor of each treated unit.
This operation may take a while.

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
78	**28**	**681.011**	**155.266**	**4.386**

Note: the numbers of treated and controls refer to actual
nearest neighbour matches

Appendix-B: Poverty Line

```
. ifgt  adulttotalconsumpti, alpha(0) pline(165)

    Poverty index   :  FGT index
    Parameter alpha :  0.00
```

Variable	Estimate	STE	LB	UB	Pov. line
adulttotalconsumpti	0.128205	0.038099	0.052340	0.204070	165.00

```
. ifgt  adulttotalconsumpti, alpha(1) pline(165)

    Poverty index   :  FGT index
    Parameter alpha :  1.00
```

Variable	Estimate	STE	LB	UB	Pov. line
adulttotalconsumpti	0.013185	0.005611	0.002012	0.024358	165.00

```
. ifgt  adulttotalconsumpti, alpha(2) pline(165)

    Poverty index   :  FGT index
    Parameter alpha :  2.00
```

Variable	Estimate	STE	LB	UB	Pov. line
adulttotalconsumpti	0.002598	0.001672	-0.000731	0.005927	165.00

```
. ifgt tatoaconexpperadult_m, alpha(0) opl(mean) prop(50)
variable tatoaconexpperadult_m not found
r(111);

. ifgt  adulttotalconsumpti, alpha(0) opl(mean) prop(50)

    Poverty index   :  FGT index
    Parameter alpha :  0.00
```

Variable	Estimate	STE	LB	UB	Pov. line
adulttotalconsumpti	0.179487	0.057073	0.065840	0.293134	174.04

```
. ifgt  adulttotalconsumpti, alpha(1) opl(mean) prop(50)

    Poverty index   :  FGT index
    Parameter alpha :  1.00
```

Variable	Estimate	STE	LB	UB	Pov. line
adulttotalconsumpti	0.020870	0.007579	0.005779	0.035961	174.04

```
. ifgt  adulttotalconsumpti, alpha(2) opl(mean) prop(50)

    Poverty index   :  FGT index
    Parameter alpha :  2.00
```

Variable	Estimate	STE	LB	UB	Pov. line
adulttotalconsumpti	0.004057	0.002329	-0.000580	0.008694	174.04

```
. dfgtg newtotalmonthlyexp_02, hgroup(acceirrigation) alpha(0) pline(315)

    Decomposition of the FGT index by groups
    Poverty index   :  FGT index
    Group variable  :  acceirrigation
    Parameter alpha :  0.00
```

Group	FGT index	Population share	Absolute contribution	Relative contribution
0	0.442308	0.396947	0.175573	0.696970
	0.069139	0.042911	0.033368	0.080308
1	0.128205	0.595420	0.076336	0.303030
	0.037999	0.043047	0.023289	0.080308
Population	0.251908	1.000000	0.251908	1.000000
	0.038074	0.000000	0.038074	0.000000

```
. dfgtg newtotalmonthlyexp_02, hgroup(acceirrigation) alpha(1) pline(315)

    Decomposition of the FGT index by groups
    Poverty index   :  FGT index
    Group variable  :  acceirrigation
    Parameter alpha :  1.00
```

Group	FGT index	Population share	Absolute contribution	Relative contribution
0	0.091026	0.396947	0.036132	0.738484
	0.019191	0.042911	0.008561	0.095518
1	0.021490	0.595420	0.012795	0.261516
	0.008805	0.043047	0.005323	0.095518
Population	0.048928	1.000000	0.048928	1.000000
	0.009722	0.000000	0.009722	0.000000

```
. dfgtg newtotalmonthlyexp_02, hgroup(acceirrigation) alpha(2) pline(315)

    Decomposition of the FGT index by groups
    Poverty index   :  FGT index
    Group variable  :  acceirrigation
    Parameter alpha :  2.00
```

Group	FGT index	Population share	Absolute contribution	Relative contribution
0	0.027292	0.396947	0.010833	0.737907
	0.007400	0.042911	0.003162	0.138396
1	0.006462	0.595420	0.003848	0.262093
	0.004119	0.043047	0.002468	0.138396
Population	0.014681	1.000000	0.014681	1.000000
	0.003931	0.000000	0.003931	0.000000

Appendix-C: Questioner

The interview schedule

Impact of community managed irrigation on household income and poverty reduction

(Case of Seharti-Samre, of Tigray Regional State)

General Instructions to Enumerators

i. Make brief introduction to the respondent before starting the interview (greet them, tell your name, get her/his name, and make clear the purpose and objective of the study that you are undertaking).
ii. Please ask the question clearly and patiently until the respondent understands.
iii. During the process put the answers of each respondent both on the space provided and encircle the choice or tick mark as required

General information

Date of interview:_____

1. Name of the Interviewer:_____Sign:_____

2. Name of the respondent:_____HH ID _____

MODULE I: HOUSEHOLD DEMOGRAPHICS AND EDUCATIONS

SECTION 1.1: BASIC HOUSEHOLD INFORMATION.

We would like to ask a few questions about all members of the household (*Beteseb*). Please include everybody who usually lives in the household (including servants etc)

[Interviewer: Write members in this order: a) Head first b) Spouse(s) c) children of head/spouse(s) d) other]

ID CODE	1. Name	2. What is the relationship of...? {Name}...to the household head **(See the cods on the above)**	3. Sex of... {Name}... **Male…. 1 Female...2**	4. Age (in years) **If Age < 1, age = 99**	5.Marital status	6. What was the highest level of schooling completed?	7.can..{Name}. Read a letter? **Yes ……. 1 No……0**	8.Can...{Name}. Write a letter? **Yes ……..1 No……0**	9. Does... {Name}. Have an adult literacy program Certificate? **Yes ……1 No……..0**
01									
02									
03									
04									
05									
06									

Code 1.2 Education codes

NEVER ANY SECHOOLING ……..**A**
RELIGIOUS/TRADITIONAL SCHOOL ……..**B**
PRIMARY SCHOOL (INCOMPLETE)…….. **...C**
PRIMARY SCHOOL (COMPLETE) ……..**....D**
GRADE 7 COMPLETE……..**...E**
GRADE 8 COMPLETE……**F**
GRADE 9 COMPLETE……..**...G**
GRADE 10 COMPLETE……..**....H**
GRADE 11 COMPLETE……..**I**
GRADE 12 COMPLETE……...**J**
TECHNICAL/VOCATIONAL……**K**
COLLEGE DIPLOMA…….. **..L**
FIRST DEGREE AT UNIVERSITY ……..**M**
POST GRADUATE ……**N**
OTHER ……**O**
SPECIFY……..

SECTION 2.1.2:INPUTS

The questions refer to all the land on which crops were harvested during the year 2003/04 on <u>rain fed farms.</u>The input questions refer to all crops as a whole.

[INTERVIWER: First ask all the questions in the following box about ploughing, then about weeding and finally about harvesting]

Activity	1.NUMBER OF OXEN USED	2.Were any members of other households involved in the activity As part of a traditional labor sharing agreement?				3.If no labor sharing or apart from working with the work group, were any members of your Household involved in...[..]..?			4.Did you hire in any labor from outside the household to work on your land during the Last year?					
		YES.1 NO...0 (IF NO, Q3)	How many members of your own household were Involved ?	How many members of other households were Involved?	How many days was the work group active for ..[..]..?	YES.1 NO...0 (IF NO, Q4)	How many household Members?	How many days IN TOTAL was worked by your Household?	No. of people (if none, write 0)	TOTAL number of days worked	Total payment: sum of all payments in cash to all workers BIRR	Total payment in kind: sum of all payments in kind to all workers **crop (e)**	**Amount**	**Unit (b)**
Ploughing and Weeding														
Harvesting														

We want to ask you some further questions about the use of input for the production of crops during the year 2003/04 on <u>rain fed farms</u>.we simply want totals for all crops.

	5. Did you use any manure from your household's herd on your fields?	6. Did you purchase any fertilizer for use on your fields?					7. Did you purchase improved seeds for use on your field?					8.Did you have any other expenses associated with crop production and the sale of crops, such as for plants, transport, tools, etc.				
	YES....1 NO.....0	YES...1 NO...0	AMOUNT	UNIT (b)	SOURCE (c)	TOTAL VALUE	Yes...1 No...0	AMOUNT	UNIT (b)	SOURCE (c)	TOTAL VALUE	YES...1 NO...0	AMOUNT	UNIT (b)	SOURCE (c)	TOTAL VALUE
TOTAL																

SECTION 2.1.3. INPUTS

The questions refer to all the land on which crops were harvested during the 2003/04using<u>irrigation</u>. The input questions refer to all crops as a whole.

[INTERVIWER: First ask all the questions in the following box about ploughing, then about weeding and finally about harvesting

Activity	1.NUMBER OF OXEN USED	2.Were any members of other households involved in the activity As part of a traditional labor sharing agreement?				3.If no labor sharing or apart from working with the work group, were any members of your Household involved in...[..]..?			4.Did you hire in any labor from outside the household to work on your land during the Last year.					
		YES.1 NO...0 (IF NO, Q3)	How many members of your own household were Involved?	How many members of other households were Involved?	How many days was the work group active for ..[..]..?	YES.1 NO...0 (IF NO, Q4)	How many household Members?	How many days IN TOTAL was worked by your Household?	No. of people (if none, write 0)	TOTAL number of days worked	Total payment: sum of all payments in cash to all workers BIRR	Total payment in kind: sum of all payments in kind to all workers **crop (e)**	**Amount**	**Unit (b)**
Ploughing Weeding														
Harvesting														

We want to ask you some further questions about the use of inputs for the production of crops during the last 2003/04season. We simply want totals for all crops.

	5. Did you use any manure from your household's herd on your fields?	6. Did you purchase any fertilizer for use on your fields?					7. Did you purchase improved seeds for use on your field?					8. Did you have any other expenses associated with crop production and the sale of crops, such as for plants, transport, tools, etc.				
	YES....1 NO.....0	YES...1 NO...0	AMOUNT	UNIT (b)	SOURCE (c)	TOTAL VALUE	Yes...1 No...0	AMOUNT	UNIT (b)	SOURCE (c)	TOTAL VALUE	YES...1 NO...0	AMOUNT	UNIT (b)	SOURCE (c)	TOTAL VALUE
TOTAL																

SECTION 2.1.4.CROP OUT PUT ANS SALE – RAIN FED FARM ANDIRRIGATION

Each crop harvested during the last season [rain fed farm and irrigation harvest 20003/04 EC], can you answer the following questions?

Plot name	**CROP CODE (a) see the above**	**2. Harvested through Irrigation … 1 Rain fed agriculture …..2**	**3. Area of land cultivated in Tsimad.**		**4. Did you use manure from your households herd on your fields? Yes --1 No ---0**	**5. Did you purchase any fertilizer for use on your fields ? Yes – 1 (Q6) No ---0 (Q7)**	**6. Use of fertilizer**			**7.How much was your harvest from last season's crop?(2003/04)**		**8.have you given any part of the harvest to others as payment for kiray /rent and /or gift**		**9. Have you sold any of the last season's harvest ? Yes...1 No...0**	**10.if you sale any part of your harvest, answer question on amount and revenue**		
			Own land	**Rented/sharecropped in**			**Quantity purchased/used**	**Unit price(Birr)**	**Total cost**	**Quantity**	**Unit (b)**	**Quantity**	**Unit (b)**		**Amount**	**Unit (b)**	**Total revenue in birr**

CODES FOR SECTION 2.1.4 AND 2.1.2 AND 2.1.3

Code -A

Codes	*List 0f Crops*	*Codes*	*List 0f Crops*
1	**WHITE&TEFF**	15	**GRASS**
2	**BLACK &MIXED TEFF**	16	**EUCALYPTUS**
3	**BARLEY**	17	**POTATOES**
4	**WHEAT**	18	**SESAME**
5	**KARKA'ETA**	19	**ONION**
6	**MAIZE**	20	**Papaya**
7	**SORGHUM**	21	**ANANAS(PINEAPPLE)**
8	**BEANS**	22	**AVOCADO**
9	**ROUNDNUTS**	23	**ORANGE**
10	**PULSES**	24	**LEMON**
11	**VEGETABLES (kosta, selata, komidere etc)**	25	**GUAVA (ZEYTUNA)**
12	**COFFEE**	26	**SUGARCANE**
13	**CHAT**	27	**OTHER**
14	**BANANAS**		

Code -B

codes	*Measurement units*
1	KILOGRAMMES
2	LEKOTA/ AKMADA
3	KAFER
4	MISHE
5	CHIRET
6	PIECES (FIKDI)
7	LITRES
8	SHEMBER
9	MINELIK

(C) SOURCE OF PURCHASED INPUTS

Code	***Source of Inputs***
1	Service Cooperative
2	Ministry or Other Public Agency
3	Non-Governmental Agency
4	Friend/Relative
5	Trader/Market
6	Other

SECTION 2.1.5: LIVESTOCK OWNERSHIP

Can you tell us about your herd of livestock at present?

Type of Livestock bulls/oxen	1. Number owned and present at your farm	2. If you would sell **ONE** of them Today, how much would you receive from the sale? BIRR	3. Number not owned but cared for	4. Number owned but away	5. During the last four months, how many were born? (since Meskerem 2004EC)	6. During the last four months, how many died or got lost?	7. Did you buy any...? [..].. During the last six months (since Meskerem 2004EC?		8.Did you sell any? Of them During the last four months?		9. How many were slaughtered IN THE LAST FOUR MONTHS?
							Number bought (if none, write 0)	Total purchase value of all bought	Number sold (if none, write 0)	Total sales value of all sold	
young bulls/Oxen											
cows											
heifer											
calves											
sheep											
goats											
horses											
camels											
mules											
Donkeys											
Beehives											
Poultry											

SECTION 2.1.6: LIVESTOCK EXPENDITURE AND INCOME

1. During the last four months, have you had any of the following expenditures related to livestock?

NO	Type of expenditure	3 cash value (if in kind, give estimated cash value)
1	labor for herding	
2	Feed, including salt	
3	veterinary services/medicine	
4	Transport of animals feed or supplies	
5	Commission on the sale of animals	
6	Other expenses	

2. Gross income from the sale of household's animal products during the last four months?

type	5 Did you sell any..[..]..? YES...1 NO....0	6 Amount sold?	7 Unit (b)	8 Total revenue obtained from the sale of... [..]..
meat				
hides/skins				
butter/cheese				
milk/cream				
dung cakes				
Eggs				
Honey				

(b) KUBAYA.....1, FEKDI.....3 , KILOGRAM.....2, LITRES.....4
OTHER.....

CODE for section 2.7.1: EMPLOYMENT FOR WAGES
Code (a) Type of employment
Farm Worker (for pay) = 1; Traditional labour sharing = 2
Professional (teacher, government worker, administration, health worker, clerical) = 3
Labourer (skilled i.e. builder, thatcher, hair cutting or dressing) = 4
Trader = 5; Soldier = 6; Driver/Mechanic =7; unskilled worker = 8;
Domestic servant = (yebetagelgay) = 9; Food/cash for work = 10;
Others = 11, specify _____

SECTION 2.7: NON-FARM ACTIVITIES AND INCOME

SECTION 2.7.1 EMPLOYMENT FOR WAGE

In the last twelve months, did any of the household members work off the household's land either on someone else's land or in some other employment or Against payment in cash/kind? If yes give the following details. ☐---- 1

No ----- 0

ID code of H.H Member	1. Kind of Work *[code a]*	2. Is it permanent (=1) or temporary (=2) Work?	3. Total days worked in each season			4. Total amount earned in Birr		
			1st season (Tir-Miazia, 2003EC)	2nd season (Ginbot-Nehassie, 2003EC)	3rd season (Meskerem-Tahisas, 2004EC)	1st season	2nd season	3rd season

SECTION 2.7.2 OWN BUSINESS ACTIVITIES

I would like to ask you about your income earning activities such as craft, trades, or other business, carried out by any of the household members this year.

If any of the household members are involved in such activities fill the following:

Activities	HH member responsible [ID code]	1. How much has the household earned net? If given in kind, change to cash and include it as payment *[tirfiTirah] and put it in Birr earned in each season*			2. Total days worked by the HH			3. Total hired labour used	
		1st season (Tir-Miazia, 2003EC)	2nd season (Ginbot-Nehassie, 2003EC)	3rd season (Meskerem-Tir, 2004EC)	1st season (Tir-Miazia, 2003EC)	2nd season (Ginbot-Nehassie, 2003EC)	3rd season (Meskerem-Tir, 2004EC)	Total days worked	Paid wage in Birr
Weaving (shimena)									
Milling (metehan)									
Handicraft, including pottery									
Hair dressing (Kuno)									
Spinning (Fetli)									
Trade in grain/general									
Trade in livestock									
Traditional healer/ Religious teacher									
Transport by pack Animal including selling salt									
Selling cactus									
Selling wood and Charcoal									
Selling Tela, Arequi, Teii, Kolo, and iniera									
Others (Specify)									

3.1. Extension service

3.1.1. Do you receive support from Development agent? (Put S mark)
Yes…….. 2. No……
3.1.2 If yes, what are the supports given? (Put S mark)
Advice…… 4.Experience sharing ……
Training (technical)…… 5.Controlling water distribution ……
Conflict resolution…… 6.Other specify…….
3.2. Access to credit
3.2.1. Have you ever used access to credit for your agricultural activities? (Put S mark)
1. Yes……. 2.No…….
3.2.2. If yes, what are the sources? (Put S mark)
Cooperatives……. 4.Local leaders…….
Microfinance institute…… 5.Other specify……
Neighbors and relatives……..
3.2.3. If No, why not? (Put S mark)
No collateral……. 4.No access to credit supply…….
High cost of access to credit…… 5. Others specify……..
No need……
3.2.3 For how money months are you apple to cover all your food consumption during the last year? ……..... months.

3.3 Access to market information
3.3.1. Do you get information about prices and demand conditions of agricultural inputs and outputs? (Put this mark✓) 1. Yes……2.No…….
3.3.3. Do you have Radio? 1. Yes…….. 2. No…….. (Put this mark✓)
3.3.4. Do you listen to agricultural program on Radio? 1. Yes……2. No……. (Put this mark✓)
3.3.5. Do you know the existence of irrigation extension services in your area?(Put this mark✓)
Yes…… 2. No……
3.4. Infrastructure/access to road on irrigation
3.4.1. How do you sell your product from irrigation general……..?(Put this mark✓)
Sell on the farm…… 3.use both methods……
Harvest and sell at market…… 4.other specify……..
3.4.2. How do you transport agricultural product to the market place?(Put this mark✓)
1. On back…… 3.donkey……..
2. Vehicle……. 4.other specify…….
3.5. Marketing function for irrigation user
3.5.1. Do you produce for market irrigation? (Put this mark✓)
Yes……. 2. No……

3.5.2. If you donot produce for market, which of the following is important reason for you? (Put this mark✓)

A. Due to lack of enough water…… C.Lack of access market demand …….

B. Due to lack of enough land…….. D. Others specify…….

3.5.3. What are the problems in marketing your produce? (Put this mark✓)

Transportation problem…… c. Others……..

Too far from market place…… d. Low price of agricultural produce……

3.5.4 what type of opportunity didi you have in your area

1…….

2……

3……

4……

3.5.5 What is the mean problem in practicing irrigation activity

1……..

2…….

3…….

43. Expenses category

4.1. FOOD CONSUMPTION OVER PAST 7 DAYS **(IN 2003/04)**

H1. Over the past one week	item Code	Yes=1, No=2	How much in total did your household eat in the 7 days?		How much came from purchases?			How much came from own production?			How much came from gifts and other sources?		
	(a)	**(b)**	**Quantity (c)**	**Unit (d)**	**Quantity (e)**	**Unit (f)**	**Birr (g)**	**Quantity (h)**	**Unit (i)**	**Birr(j)**	**Quantity (k)**	**Unit (l)**	**Birr (m)**
Cereals, Grains and Cereal Products	**1-9**												
Teff	01												
Wheat	02												
Barley	03												
Maize	04												
Sorghum	05												
Millet	06												

H1. Over the past one week	item Code	Yes=1, No=2	How much in total did your household eat in the 7 days?		How much came from purchases?			How much came from own production?			How much came from gifts and other sources?		
	(a)	**(b)**	**Quantity (c)**	**Unit (d)**	**Quantity (e)**	**Unit (f)**	**Birr (g)**	**Quantity (h)**	**Unit (i)**	**Birr(j)**	**Quantity (k)**	**Unit (l)**	**Birr (m)**
Vegetable	**7-13**												
Onion	07												
Garlic	08												
Potato	09												
Tomato	10												
Cabbage	11												
Carrot	12												
Selata	13												
Fruit	**14-18**												
Banana	14												
Mango	15												
Orange	16												
Avocado	17												
Guava	18												

H1. Over the past one week	item Code	Yes=1, No=2	How much in total did your household eat in the 7 days?		How much came from purchases?			How much came from own production?			How much came from gifts and other sources?		
	(a)	**(b)**	**Quantity (c)**	**Unit (d)**	**Quantity (e)**	**Unit (f)**	**Birr (g)**	**Quantity (h)**	**Unit (i)**	**Birr(j)**	**Quantity (k)**	**Unit (l)**	**Birr (m)**
Animal product	**19-25**												
Eggs	19												
Milk	20												
Beef	21												
Chicken	22												
Butter	23												
Honey	24												
Other	**25-32**												
Suger	25												
Cooking oil	26												
Salt	27												
Coffee	28												
Local beer(suwa	29												
Beer	30												

H1. Over the past one week	item Code	Yes=1, No=2	How much in total did your household eat in the 7 days?		How much came from purchases?			How much came from own production?			How much came from gifts and other sources?		
	(a)	**(b)**	**Quantity (c)**	**Unit (d)**	**Quantity (e)**	**Unit (f)**	**Birr (g)**	**Quantity (h)**	**Unit (i)**	**Birr(j)**	**Quantity (k)**	**Unit (l)**	**Birr (m)**
Local areki	31												
Hair food	32												

CODES 1 = FOR KILOGRAM 2 = FOR MILILIK 3= FOR SHEMBER 4 =FOR LITER 5= FOR UNIt

4.1.2 NON-FOOD consumption expenditure
One month Recall in 2003/04

Non- Food Items	Item code	Yes=1 No=2>>Next Item	How much did your household pay in total? ?
H2. Over the past one month (30 days), did your household use or buy or pay for any [ITEM]?	33-46 (a)	**(b)**	**BIRR** **(c)**
Matches	33		
Batteries	34		
Candles (tua'af), incense	35		
Laundry soap/omo	36		
Hand soap	37		
Charcoal	38		
Firewood	39		
Cigarettes, tobacco,	40		
Transport	41		
House rent	42		
Water fee	43		
Electricity	44		
Hear dressing	45		
Other, specify	46		

4.1.3 NON-FOOD EXPENDITURES OVER PAST 12 MONTH

Over the past 12 months, did your household purchase or pay for any [ITEM]?	Item code	Yes=1 No=2>>Next Item	How much did your household pay in total?
	(a)	**(b)**	**BIRR (c)**
Over the past 12 months, did your household use or buy any [...]?	**47-64**		
Clothes/shoes/fabric for MEN	47		
Clothes/shoes/fabric for WOMEN	48		
Clothes/shoes/fabric for BOYS	49		
Clothes/shoes/fabric for GIRLS	50		
Kitchen equipment (cooking pots, etc.)	51		
Lamp/torch	52		
Contributions to IDDIR	53		
Donations to the church/mosque	54		
Blanket/bed sheet	55		
Umbrella	56		
School fee	57		

Stationary Materials (exercise books, pen and books)	58		
School Uniform	59		
Land tax and other levies	60		
Funeral expense	61		
Health expense	62		
Marriage ceremony- gift	63		
House maintenance	64		

4.1.4 DURABLE GOODS EXPENDITURES OF 12 MONTHS IN 2003/04

H3. Does your household own a [ITEM]?	ITEM CODE	YES=1 NO=2	How many [ITEM] do you own?	What is the age of these [ITEM]? IF MORE THAN ONE ITEM, AVERAGE AGE.	If you wanted to sell or rent one of these items today, how much would you receive? IF MORE THAN ONE, AVERAGE VAUE.	Did you purchase any of these ITEM Yes=1 No=2	Buying price
	64-83		**Number**	**Year**	**BIRR**		**BIRR**
Bed	64						
Table(s)	65						
Chair(s)	66						
Radio/Tape	77						
Television	78						
Sofa	79						
Shelves	80						
Bicycle	81						
Clock	82						
Other –specify	83						